Draft

Lewis County Critical Areas Ordinance

Best Available Science Review and Recommendations for Code Update

Fish and Aquatic Resources

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Prepared for

Lewis County Community Development Department
Planning Division
350 N Market Blvd.
Chehalis, WA 98532

Prepared by

Parametrix
411 108th Avenue NE, Suite 1800
Bellevue, Washington 98004-5571
(425) 458-6200
www.parametrix.com

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ACRONYMS

BAS	Best Available Science
BMPs	best management practices
CAC	Citizens' Advisory Committee
CTED	Community Trade and Economic Development
CTP	Cooperative Technical Partnership
ESU	Evolutionarily Significant Unit
GMA	Growth Management Act
HCAs	Habitat conservation areas
HMP	Hazard Mitigation Plan
LCC	Lewis County Code
LCPW	Lewis Public Works
LWD	Large woody debris
NWS	National Weather Service
SCS	Soil Conservation Service
SMP	Shoreline Master Program
SPTH	Site-potential tree height
UGB	Urban Growth Boundary
USACE	U.S. Army Corps of Engineers
WRIA	Water Resource Inventory Area

1. INTRODUCTION

In 1995, the Washington State Legislature amended the Growth Management Act (GMA) to require that local governments include Best Available Science (BAS) in designating and protecting critical areas (RCW § 36.70A.172(1)). In 2000, the State's Office of Community Trade and Economic Development (CTED) adopted procedural criteria to implement these changes to the GMA and provided guidance for identifying BAS. The rule makers concluded that identifying and describing functions and values and estimating the types and likely magnitudes of adverse impacts were scientific activities. Thus, RCW 36.70A.172(1) and the implementing regulations require the substantive inclusion of BAS in developing critical area policies and regulations.

The Lewis County critical areas ordinance (CAO) addresses the following (LCC 17.35):

- Wetlands
- Fisheries habitat
- Wildlife habitat
- Frequently flooded area
- Aquifer recharge areas
- Geologically hazardous areas

This document summarizes BAS for Lewis County fisheries habitat critical areas and provides options for updating the County's critical areas ordinance (Chapter 17.35 of the Lewis County Code [LCC]). In addition, this document addresses the habitat requirements and management needs of anadromous fish. Maps of the County's critical areas are provided in Appendix A.

1.1 REPORT BACKGROUND AND PURPOSE

The information contained within this document is a summary of scientific studies related to designating and protecting critical areas, including habitat for anadromous fish species, as defined by the GMA. The information provides a basis for recommended changes and additions to the Lewis County critical areas ordinance[1]. It is not intended to provide an exhaustive summary of all science available for all critical areas. The information reviewed is pertinent to Lewis County, applicable to the types of critical areas present, and is believed to be the best available scientific information. BAS means current scientific information derived from research, monitoring, inventory, survey, modeling, assessment, synthesis, and expert opinion that is:

- Logical and reasonable
- Based on quantitative analysis
- Peer reviewed
- Used in the appropriate context
- Based on accepted methods
- Well referenced [2]

[1] In some instances, the BAS review supports existing provisions of the County code and no changes are recommended.

[2] Washington Administrative Code (WAC) 365-195-900 through 925

This report is devoted to fisheries habitat, which is a specific critical area designated in LCC 17.35. In many cases, the information presented for one critical area overlaps, complements, or is applicable to another type of critical area because these areas function as integrated components of the ecosystem. The following sections summarize the information and issues that the County is required to consider within its process for updating policies and regulations to protect the functions and values of critical areas (RCW §36.70A.172.1).

In some instances the GMA and its regulations constrain the choice of science that can be used to designate or protect a particular resource (e.g., local governments are required to use the definition of wetlands [RCW 36.70A.030.2]). In other cases, there may a range of options that are supported by science (e.g., wetland buffer widths necessary to protect functions).

The State legislature and the Growth Management Hearings Boards have defined critical area "protection" to mean preservation of critical area "structure, function, and value" (CPSGMHB 1996) Local governments are not required to protect all functions and values of all critical areas, but are required to achieve "no net loss" of critical area functions and values across the jurisdictional landscape. Local governments are also required to develop regulations that reduce hazards associated with some types of critical areas including geologically hazardous areas and frequently flooded areas. The standard of protection is to prevent adverse impacts to critical areas, to mitigate adverse impacts, and/or reduce risks associated with hazard areas.

This report was prepared by qualified scientists acting as consultants for County staff. A Critical Areas Technical Group (CATG) composed of experts from federal, state, tribal and local agencies (Appendix B) reviewed all of information presented here in draft form and provided comments. In many cases CATG members provided scientific studies and data to be included in the review.

1.2 RELATIONSHIP TO OTHER PLANNING EFFORTS

The recommendations derived from the BAS review will be used as the basis for revising the County's development regulations and Comprehensive Plan elements that pertain to critical areas. The County is required to integrate critical areas protection into zoning regulations, clearing and grading provisions, stormwater management requirements, subdivisions regulations and other applicable plans and policies. The County is also required to integrate the CAO provisions into its Shoreline Master Program (SMP), which must be updated by the end of 2012. To comply with House Bill 1933, SMP regulations pertaining to critical areas must be as protective of functions and values as the CAO regulations themselves or more protective.

1.3 COUNTY SETTING

Lewis County is located in the southwest portion of the State and has an area of 2,452 square miles. The crest of the Cascade Mountains forms the eastern boundary of the County, which is abutted by Yakima County and the Yakima Indian Reservation. Lewis County is bounded by Thurston and Pierce Counties to the north, Grays Harbor and Pacific County to the west, and Wahkiakum, Cowlitz, and Skamania Counties to the south. The location of the county is shown in the Vicinity Map in Figure 1.

The County includes the cities of Centralia, Chehalis, Winlock, Napavine, Morton, Mossyrock, Pe Ell, Toledo, and Vader. Approximately 60 percent of the County population of 71,000 lives outside of cities in unincorporated areas. Lewis County's two largest cities, Centralia and Chehalis, are located along Interstate 5 in the western portion of the county and have populations of about 15,350 and 7,000, respectively.

Figure 1. Vicinity Map

Federal lands within Lewis County include portions of the Mt. Baker-Snoqualmie National Forest, the Gifford Pinchot National Forest, the Mt. St. Helens National Volcanic Monument, Mt. Rainier National Park, and the Goat Rocks Wilderness area. Reservation and trust lands of the Chehalis Indian Nation are also located within the County.

According to the Lewis County Comprehensive Plan, about 74 percent of land within the County is committed to federal, state, and private resource land uses. Most of this land is primarily used for mineral, agricultural, forestry, and recreational uses. Only 1 percent of this resource land lies within urban areas. Over 98 percent of Lewis County is classified as open space or remote rural area and less than 2 percent is available for urban or more intense rural development.

The majority of Lewis County is located within Water Resource Inventory Areas (WRIAs) 23 and 26, the Chehalis and Cowlitz River basins respectively. A moderately sized portion of the Nisqually River basin (WRIA 11) is located within the north central part of the County. Small headwater portions of the Deschutes River Basin (WRIA 13), and the Grays River Basin (WRIA 25) are also located within Lewis County. The major watersheds and streams, including the current county classification are shown in Figure 2.

The county includes the upper Chehalis Valley, much of the Cowlitz River Drainage, and numerous other creeks draining the foothills and mountains. The Cowlitz River flows from the Cowlitz Glacier and the valley extends west about 80 miles from the rugged glacially modified mountains to the southwest part of Lewis County with bottom lands, terraces, and broad plains. The Chehalis River Valley is located in the southern part of the Puget Trough and includes broad, well-developed flood plains and low terraces surrounded by dissected uplands of low to moderate relief with rounded ridges (Evans and Fibich 1987). The Nisqually River is fed by the Nisqually Glacier on Mount Rainier and forms part of the northern boundary of Lewis County.

Tectonic and volcanic activity, glaciations, and rivers have shaped the landforms that make up Lewis County. Glacial advances from the area volcanoes and highlands eroded the underlying bedrock, creating steep mountainsides and depositing glacial sediments such as lake deposits, till, and outwash. The rivers cut through the outwash and carried coarse and fine sediments (Williams et al. 1975; WSCC 2000, 2001).

Figure 2. Watersheds and Stream Classification

Note to WP Insert two pages for two 11 x 17 sheets

2. FISH AND OTHER AQUATIC SPECIES

This analysis is focused on fish and other aquatic species and their habitats on non-federal lands in Lewis County, with special emphasis on anadromous salmonids. State GMA guidelines (Ousley et al. 2003), suggest the following habitat types that should be designated as fish and wildlife habitat conservation areas (FWHCAs) in accordance with the GMA procedural criteria for adopting comprehensive plans and development regulations (WAC 365-190):

- Areas with which state or federally listed species (endangered, threatened, or sensitive) have a primary association.

  The U.S. Fish and Wildlife Service (USFWS) and National Oceanic and National Marine Fisheries Service (NMFS) are responsible for species that are listed under the Endangered Species Act (ESA) and should be consulted for current listing status. The Washington Department of Fish and Wildlife (WDFW) is responsible for designating state special-status species and maintains the current list of these species (Ousley et al. 2003).

- Naturally occurring ponds under twenty (20) acres.

  Naturally occurring ponds and ponds created for wetland/critical areas mitigation may provide fish and wildlife habitat and other wetland functions. These ponds do not include other manmade ponds (farm ponds, detention ponds) (Ousley et al. 2003).

- Waters of the State.

  Waters of the State include surface waters and watercourses within State jurisdiction as defined in WAC 222-16-030 or WAC 222-16-031 (Ousley et al. 2003).

- Lakes, ponds, streams, and rivers planted with game fish by a government or tribal entity.

  These waters provide a valuable public recreational and commercial resource.

- State natural area preserves and natural resource conservation areas.

  Natural area preserves and natural resource conservation areas, owned and administered by the Washington State Department of Natural Resources (WDNR), represent unique or high-quality undisturbed ecosystems and habitats (WDNR 2004).

- Land essential for preserving connections between habitat blocks and open space.

  Maintaining habitat connectivity for fish and wildlife species is necessary to sustain population viability. Habitat connectivity enables individuals to move between habitat patches in obtaining requisite resources, the dispersal of individuals, and genetic exchange between populations. Isolated populations are at greater risk of extinction due to natural population fluctuations, random events, and inbreeding (Morrison et al. 1998; Lemkuhl et al. 2001).

2.1 OVERVIEW OF INVENTORY

The aquatic habitats of Lewis County support a number of special status-species and priority habitats and species. Within the County, there are several thousand miles of riverine/stream habitat and numerous large lakes and reservoirs. The Chehalis and Cowlitz are the predominant river systems, draining 2,200 and 2,480 square miles, respectively. The Cowlitz and Chehalis systems both support Chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), and chum (*O. keta*) salmon as well as steelhead (*O. mykiss*) and cutthroat trout (*O. clarki clarki*) (WSCC 2000, 2001). Eulachon (*Thaleichthys pacificus*) are also present in the Cowlitz system, while bull trout/Dolly Varden (*Salvelinus confluentus/malma*) presence in either system is considered unlikely. The principal aquatic priority habitats on non-federal lands in the County are found along the Cowlitz and Chehalis Rivers and their major tributaries. Further discussion of Lewis County's FWHCAs with respect to fish species and aquatic habitat is provided below.

2.1.1 Priority Species and Habitats

Lewis County supports many different types of aquatic species and their associated habitat. These include federal and state designated priority species, rivers, lakes, and ponds. An overview of the habitat requirements and distribution of aquatic life in Lewis County waterbodies, including listing status, is included in Table 2-1 and discussed in more detail below.

2.1.1.1 Listed Species Habitat

Listed fish species found within Lewis County include the Lower Columbia River Chinook salmon evolutionarily significant unit (ESU), the Lower Columbia River steelhead ESU, and the Columbia River chum salmon ESU (NOAA Fisheries 2006). As defined and administered by USFWS, bull trout are a threatened species; however, although they are known to inhabit the lower reaches of the Chehalis River, bull trout have not been recently documented within Lewis County (WSCC 2001).

2.1.1.2 State Priority Habitats and Species

The LCC explicitly designates priority habitats and priority species (as identified by WDFW) as separate categories of fish and wildlife habitat conservation areas [Chapter 17.35.195(a) and (2)]. State priority habitats and habitats associated with state priority species include areas having high recreational value or relatively rare species. Of particular importance or concern in Lewis County are salmonids listed as state priority species. Salmonid-bearing streams in Lewis County generally contain several anadromous and/or resident priority salmonid species, including Chinook, coho, and chum salmon, rainbow/steelhead trout, and coastal cutthroat trout (Table 2-1). Salmon are also associated with other types of priority habitats and species, particularly in relation to riparian areas; therefore, the protection of salmonid habitats serves to protect other species dependent on similar or associated habitats. River lamprey (*Lampetra ayresi*) is a State candidate anadromous species potentially found in Lewis County streams. Non-anadromous State priority fish species potentially present in Lewis County also include the pygmy whitefish (*Prosopium coulteri*), mountain sucker (*Catostomus platyrhynchus*), lake chub (*Couesius plumbeus*), leopard dace (*Rhinichthys falcatus*), green sturgeon (*Acipenser medirostris*), white sturgeon (*A. transmontanus*), channel catfish (*Ictalurus punctatus*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M salmoides*), and walleye (*Stizostedion canadense*).

2.1.1.3 Naturally Occurring Ponds

Refer to Wildlife Chapter.

2.1.1.4 Waters with Planted Game Fish

Information on water bodies with planted game fish is not available in the Priority Habitats and Species (PHS) data. However, WDFW's 2006 Catchable Trout program in Lewis County focuses on Mayfield Lake, Mineral Lake, Swofford Pond, and Carlisle Pond (WDFW 2006). Smaller numbers of trout plants, including some fry plants, occurs at about 16 other lakes and ponds in Lewis County (WDFW 2006). In western Washington, WDFW does not typically plant other game fish species and they have not planted any catchable trout in Lewis County streams in 2006 (WDFW 2006).

Table 2-1. Habitat Associations and Distribution of Priority and Listed Fish Species in Lewis County

Species	Federal and State Status1	General location/distribution
Chinook salmon Lower Columbia River ESU Washington Coast ESU	 FT, SC, Priority Species Priority Species	*Habitat:* Juveniles and adults require cold, well-oxygenated water. Spawning generally occurs in riffle areas with clean gravel and cobble substrates. Juveniles use pool habitat and instream cover such as large woody debris (LWD), spaces among cobbles, and undercut banks as resting areas and/or for refuge from predators. Cobble substrate and off-channel habitats such as secondary channels, backwaters, or ponds provide important refuge from flows for overwintering juveniles. After river entry, adults on spawning migration use resting pools, which provide refuge from river currents and high water temperatures that are often encountered in the summer and early autumn. Nearshore marine areas are important for feeding and refuge for juveniles after entering the ocean. *Distribution:* Lewis County supports both fall and spring Chinook salmon stocks. In the Cowlitz River, the primary spring Chinook stock spawns mainly in the mainstem Cowlitz River between the Cowlitz Salmon and Trout Hatcheries. Fish which are trucked above the Cowlitz Falls dam spawn in the upper Cowlitz and Cispus Rivers. A small run is also present in the Toutle River subbasin. In the Chehalis basin, spring Chinook salmon in Lewis County are found primarily in the Skookumchuck, Newaukum, and upper mainstem Chehalis (RM 88 to 108). Fall Chinook are found through the Chehalis River basin upstream of the Satsop River. Primary areas used include the mainstem (RM 80 to 108) and the Skookumchuck River. The South Fork Chehalis River, Stillman Creek, and the Newaukum River are used to a lesser degree. In Lewis County, fall Chinook in the Cowlitz basin spawn primarily in the eight-mile stretch between the Cowlitz Trout Hatchery and the Cowlitz Salmon. Hatchery fish accounted for 85 percent of the natural escapement in 1983, although there were over 30 miles of suitable spawning habitat available below the Cowlitz Salmon Hatchery. *When habitats are occupied:* Fall Chinook adults migrate from September through October and spawn from October to November. Spring Chinook adults spawn from August to October. Juveniles of both stocks can be found rearing in streams year-round.
Coho salmon Lower Columbia River ESU Southwest Washington ESU	 FT, Priority Species Priority Species	*Habitat:* Similar general habitat associations as Chinook salmon (see above). Juveniles use pool habitat and instream cover such as LWD, spaces among cobbles, and undercut banks as resting areas and/or refuge. Juvenile coho salmon overwinter in fresh water so overwinter habitat such as deep pools and off-channel habitats are of particular importance for survival, especially in streams subject to high fall and winter flows. *Distribution:* Coho salmon occur throughout the Chehalis River upper mainstem, mainstem East and West Forks, and all suitable accessible tributaries. *When habitats are occupied:* Coho salmon adults migrate and are in streams from October to as late as February, and spawn from November to as late as February. Juveniles can be found rearing in streams year-round.

Table 2-1. Habitat Associations and Distribution of Priority and Listed Fish Species in Lewis County (continued)

Species	Federal and State Status1	General location/distribution
Chum salmon Columbia River ESU Pacific Coast ESU	 FT, SC, Priority Species Priority Species	*Habitat:* Chum salmon rear in fresh water for only a few days to weeks before migrating downstream to saltwater, therefore juveniles have limited habitat needs in fresh water. Migrating spawning adults require cold well-oxygenated water, resting pools, and clean gravel spawning substrate. Chum salmon often spawn in shallower, slower-running streams and side channels in low gradient lower reaches of rivers. *Distribution:* One identified stock of chum salmon occurs in Lewis County. Fall chum spawn in the mainstem Chehalis, downstream from Lincoln Creek. In addition a small number of chum spawn in the mainstem Cowlitz River, downstream from the dams. *When habitats are occupied:* Chum salmon adults migrate and are in streams from September to December, and spawn from October to December. Fry migrate seaward shortly after hatching with no juvenile rearing in fresh water.
Rainbow Trout/steelhead Lower Columbia River DPS Southwest Washington DPS	 FT, SC, Priority Species Priority Species	*Habitat:* Similar general instream habitat requirements as other salmonids. Steelhead have an extended freshwater juvenile fresh water phase as with Chinook and coho salmon, but also require habitat for feeding and resting during an extended adult fresh water phase. *Distribution:* Both winter-run and one summer-run steelhead are found in Lewis County. Winter steelhead are present in the mainstem Chehalis and its tributaries, including South Fork Chehalis, Skookumchuck River, Newaukum River, Stillman Creek, and Lincoln Creek. Small numbers of summer steelhead spawn in the Chehalis, but specific spawning locations are unknown. *When habitats are occupied:* Resident rainbow trout are found in fresh waters year-round. Winter steelhead return to their spawning grounds from December to May, and spawning occurs from February to June. Summer steelhead adults are potentially found in streams year-round, but spawning is thought to occur from February to April, with surviving adults outmigrating to the ocean shortly thereafter. Juveniles of both life-history forms rear in fresh waters year-round prior to outmigrating to the ocean.
Coastal Cutthroat Trout	Priority Species	*Habitat:* Cutthroat trout have similar general requirements as all salmonids and display varying degrees of migratory behavior, often moving out to nearshore marine waters and estuaries to feed in the summer and migrating to freshwater streams to overwinter prior to spawning in the spring. *Distribution:* Two stocks of coastal cutthroat trout (Chehalis and Cowlitz) are widely found throughout Lewis County streams upstream and downstream of most migration barriers. *When habitats are occupied:* The life-history of coastal cutthroats is highly variable. Portions of populations are anadromous, but this behavior is not obligatory and coastal cutthroat trout adults and juveniles occur in fresh waters year-round.

Table 2-1. Habitat Associations and Distribution of Priority and Listed Fish Species in Lewis County (continued)

Species	Federal and State Status1	General location/distribution
River Lamprey *Lampetra ayresii*	SC	*Habitat:* River lamprey are anadromous and require clean gravel substrate in streams for spawning and egg incubation. After hatching, lamprey burrow in silt and mud, often in off-channel areas, where they typically remain for a period of years. During this stage, lamprey require relatively stable habitats (Close et al. 1995). *Distribution:* Found in coastal streams from northern California to southeastern Alaska, but little information available regarding the population status of river lamprey in Washington. *When habitats are occupied:* River lamprey migrate up small fresh water streams in the fall and spawn in the winter and spring. However, the ammocoete (juvenile) stage lasts several years so river lamprey would be expected to occur year-round in streams where they are found.

Primary sources: LCFRB (2004); Caldwell and Pacheco (2004); WDF et al. (1993), WDFW (1998, 2000), WSCC (2000, 2001), Williams et al. (1975),

[1] FT = Federally Threatened, SC = State Candidate, SS = State Sensitive. Note: Candidate species are not required to be included in the definition of fish and wildlife habitat conservation areas (WAC 366-190.080)

2.1.1.5 State Natural Areas

Refer to Wildlife Chapter.

2.1.1.6 Lands Essential for Habitat Connectivity

Refer to Wildlife Chapter.

2.1.1.7 Other Potential FWHCAs for Lewis County

Refer to Wildlife Chapter.

2.1.2 Aquatic Habitats

The predominant aquatic habitats in Lewis County are freshwater rivers, lakes, and streams, primarily those associated with the Chehalis, Cowlitz, and Nisqually basins. These habitats support numerous species of salmon and trout. However, all three of these basins have limited fish passage due to the presence of dams. Hydropower development in the Cowlitz and Nisqually rivers has had a large impact on fish habitat in Lewis County and the construction of dams on the Cowlitz River has removed hundreds of miles of channel from anadromous fish access (WSCC 2000, 2001). The three primary dams on the Cowlitz River are described below:

- Cowlitz Falls Dam was constructed in 1994 just below Lower Cowlitz Falls, flooding 610 acres and extending 11 miles upstream (Lake Scanewa). It is the uppermost hydropower project on the Cowlitz River (RM 88.5) and is owned and operated by Lewis County Public Utility District (PUD) No. 1. It is a run-of-the-river facility (no significant storage) that creates daily fluctuations related to power production.
- The 606-foot-high Mossyrock Dam (RM 66) was created in 1968 and is operated by Tacoma Power. The dam now impounds water upriver for 23.8 miles and provides 1,686,000 acre-feet of storage in Riffe Lake. Riffe is operated as an annual storage reservoir for flood control and hydropower with large fluctuations (raised in the spring and drawn down in the fall in preparation for winter flows) in water levels during the year (Gaia Northwest, Inc. 1993). Due to the height of the dam, length of the reservoir, depth of the penstock intakes, and location of Cowlitz Falls Dam upstream of Mayfield Dam, fish facilities were not incorporated into the dam (Gaia Northwest, Inc. 1993).
- Mayfield Dam (RM 52) was built at the foot of Mayfield Canyon (RM 52) creating Mayfield Lake in 1962. Mayfield Dam is also operated by Tacoma Power. Although the lake extends 13.5 miles upstream from the dam, the lake has a relatively small 133,764 acre-foot capacity. Mayfield Lake provides little flood storage capacity and flows from Mayfield Dam are largely in response to the regulation of flows through Mossyrock Dam. Upstream passage facilities were utilized until 1969 until it was determined that downstream migrants could not be passed around Mossyrock Dam (Gaia Northwest, Inc. 1993). Since 1969, all adult salmon and steelhead passed upstream of Mayfield Dam have been hauled via trucks, and no natural passage remains (Gaia Northwest, Inc. 1993).

Alder and LaGrande Dams, located on the Nisqually River (near RM 43), both preclude upstream and downstream anadromous fish passage and preclude salmonid access to about 30 miles of stream supporting suitable habitat.

Numerous natural and manmade lakes occur within Lewis County. The three largest waterbodies, in order of size, are Riffe Lake. Mayfield Lakes and Lake Scanewa, all created by dams placed on the Cowlitz River. Significant natural lakes within Lewis County include Wallupt, Packwood, and Mineral Lakes.

Other native and non-native sportfish species found in the County include kokanee (*O. nerka*) (found in Mayfield Lake), brook trout (*Salvelinus fontinalis*), lake trout (*Salvelinus namaycush*), yellow perch (*Perca flavescens*), brown bullhead (*Ictalurus nebulosus*), bluegill (*Lepomis macrochirus*), crappie (*Pomoxis nigromaculatus*), largemouth bass, smallmouth bass, and eulachon.

While freshwater aquatic habitats support a wide variety of aquatic organisms, of special concern is the condition of freshwater aquatic habitats necessary to support anadromous salmonids. A discussion of habitat requirements of anadromous salmonid species is presented in the following section.

2.1.2.1 Habitats for Anadromous Salmonid Species

All anadromous salmonid species in Lewis County are considered priority species. Habitats for anadromous salmonid species include both fresh and marine waters. Habitat use is dependent on the life-stage and species, but in general there is considerable overlap in the range of habitat variables used by different salmonid species. Freshwater streams provide spawning and early rearing habitat for all anadromous fish species, whereas marine waters are where anadromous fish grow to maturity prior to returning to fresh waters to spawn. Freshwater salmonid life stages require cold-water streams having complex structural habitat and clean gravels free of fine sediment. Upon hatching, juveniles spend varying lengths of time (from mere days to greater than 2 years depending on species and stock) in freshwater prior to migrating to sea. After entering the estuary, juvenile salmonids typically spend a period of time inhabiting and foraging among coastal and estuarine shoreline habitats.

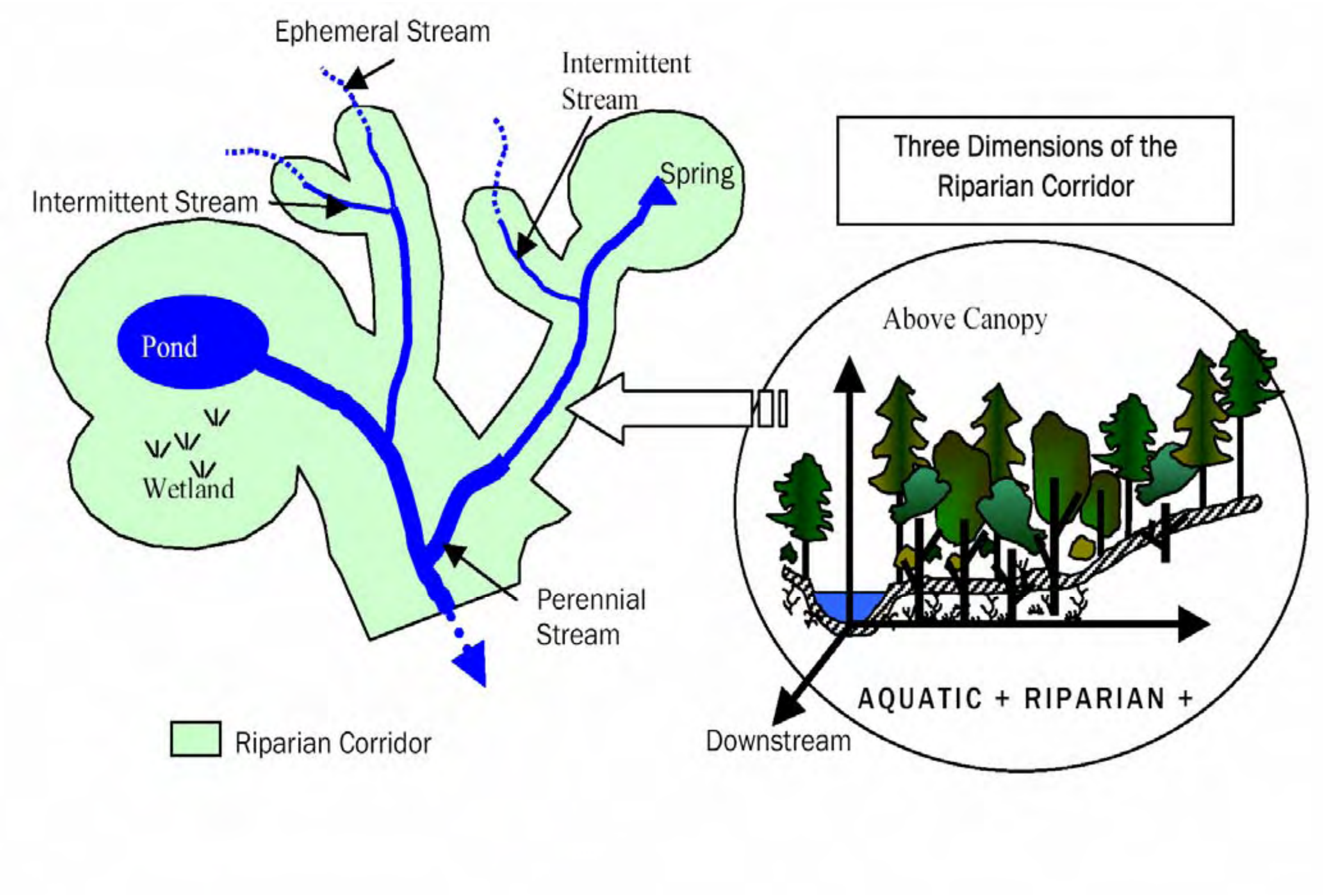
Numerous streams and rivers of Lewis County contain anadromous salmonid species, and many of these areas support habitats required by anadromous salmonids. The Cowlitz River and associated tributaries drain the majority of eastern Lewis County. Major tributaries of the mainstem Cowlitz include the Tilton, Cispus, Ohanapecosh, and Green Rivers, and the Muddy Fork Cowlitz River. Within the Chehalis basin, the mainstem, South Fork, East Fork and West Fork of the Chehalis river all contain several anadromous salmonid species, as do major tributaries such as the Newaukum and Skookumchuck Rivers. The Nisqually River and its primary tributary in Lewis County, Mineral Creek, do not contain anadromous salmonids due to the presence of dams downstream of Alder Lake, although resident cutthroat trout are present. An overview of the status, habitat associations and distribution of anadromous salmonid species in Lewis County is found in Table 2-1.

2.2 OVERVIEW OF AQUATIC HABITAT FUNCTIONS AND VALUES

Productive salmonid habitat is necessarily complex owing to the myriad requirements of various life-stages. Salmonids require cold clean waters, silt-free substrates, natural flow conditions, and structurally complex habitat suitable for spawning, rearing, and migration. The important aquatic habitat features for supporting salmonid populations include riparian condition, large wood debris (LWD) recruitment, fish passage, floodplain connectivity, channel migration, bank stability, pools, off-channel habitat, substrate/fines, water quality, and hydrology. Lakes and ponds also provide essential functions for many aquatic species, including salmonids.

Riparian areas are the zones where aquatic and terrestrial ecosystems interact. The riparian area includes a variety of systems that interact and together provide essential functions. Elements of the riparian area includes underlying geology, topography, landforms, and soils, the vegetation community, stream channels, both perennial and ephemeral, ponds, lakes wetlands, and is influenced by regional processes such as weather and rainfall patterns. Riparian areas have variable widths that are determined by ecologically important functions, rather than arbitrary distances. A simplified schematic of riparian areas or corridors is included in Figure 3.

Figure 3.Riparian Areas



Riparian vegetation provides habitat for many species of wildlife. Streamside or shoreline vegetation provides habitat functions for streams and fish such as shade, bank stability, sediment/nutrient filtering, and organic nutrient input. In addition, riparian vegetation interacts with natural erosional and depositional processes of streams as channels migrate across valley bottoms to form instream habitat. As channels move back and forth through this channel migration zone (CMZ), instream pools and riffles are formed. Channel migration also promotes floodplain connectivity and recruitment of LWD, which can be a primary factor influencing channel form by the creation pools, riffles and off-channel habitats that are essential to support all life stages of anadromous salmonids (May 2000).

Historically, natural riparian corridors in the Pacific Northwest were nearly continuous and the importance of riparian continuity is widely recognized (May et al. 1997; Naiman and Bilby 1998; Wenger 1999). Riparian corridor continuity is particularly important in smaller headwater streams because smaller streams generally make up most of the stream length within a watershed, and the influence of riparian vegetation on some stream habitat functions is greater for small streams (Binford and Bucheneau 1993; Wenger 1999; Beschta et al. 1987). Such areas upstream of fish-bearing waters help determine water quality, the magnitude and timing of flows, stream temperature, sediment, nutrients, and prey production in downstream waters.

Along lake shorelines, riparian vegetation is also a key element of ecological function and has a significant influence on the habitat value of the riparian zone, and in adjacent aquatic and terrestrial areas. Though not as well defined as for riverine systems, freshwater shoreline riparian zones serve many of the same functions (e.g., LWD, shading, organic matter production, sediment filtration, microclimate), as well as some additional functions unique to shorelines (Gregory et al. 1991; Naiman et al. 1992).

The following discussion is a review of major riparian functions and the level of functionality afforded by riparian buffers of varying widths as reported in the literature. Tables 2-2, 2-3, and 2-4 summarize the conclusions and recommendations for riparian buffer widths in frequently cited literature reviews of riparian buffer functions. These tables are not intended to be prescriptive, but do serve to illustrate the wide range of effective buffer widths reported in the literature, and also provide recommendations based on providing a reasonable level of habitat functionality under most conditions. It must be recognized that a single prescription is not necessarily appropriate or warranted for all situations. Buffer recommendations and functionality is frequently expressed in terms of site-potential tree height (SPTH), which is the height of mature trees that a given site can be expected to support. Figure 4 displays how the effectiveness of individual riparian functions in forested systems varies based on the SPTH distance from the stream. Some riparian functions, such as bank stability, may be adequately maintained with a forested buffer of 0.25 SPTH, while other functions, such as the maintenance of adequate LWD recruitment would require a forested buffer near 0.75 SPTH. Following the tables and figures, further discussion of riparian functionality and considerations for determining buffer effectiveness is provided. In addition, riparian functions for lake shorelines are included in the discussion where appropriate.

Table 2-2. Stream Riparian Functions and Appropriate Widths Identified by May (2000)[1].

Function	Range of Effective Buffer Widths	Minimum Recommended Width	Notes On Function
Large Woody Debris	10 to 100 m (33 to 328 feet)	80 m (262 feet)	1 SPTH based on long-term natural levels
Water Temperature	11 to 43 m (36 to 141 feet)	30 m (98 feet)	Based on adequate shade
Sediment removal and erosion control	8 to 183 m (26 to 600 feet)	30 m (98 feet)	For 80% sediment removal
Pollutant Removal	4 to 262 m (13 to 860 feet)	30 m (98 feet)	For 80% nutrient removal
Microclimate	45 to 200 m (148 to 656 feet)	100 m (328 feet)	Optimum long-term support

[1] May (2000) recommendation for an overall minimum buffer width is 30 m (98 feet), with the understanding that full effectiveness may not be achieved for some functions such as LWD, wildlife habitat, and microclimate.

Table 2-3. Stream Riparian Functions and Appropriate Widths Identified by Knutson and Naef (1997)

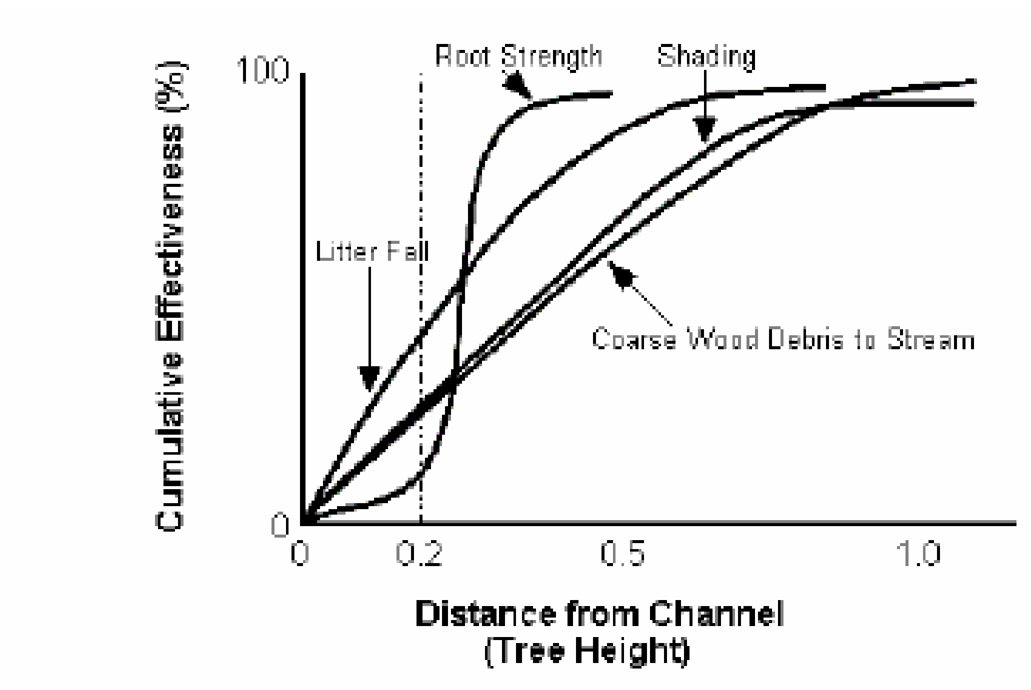
Function	Range of Effective Buffer Widths (feet)
Large Woody Debris	100 to 200
Water Temperature	35 to 151
Erosion Control	100 to 125
Sediment filtration	26 to 300
Pollutant Removal	13 to 600
Microclimate	200 to 525

Table 2-4. Stream Riparian Functions and Appropriate Widths Identified from FEMAT (1993)

Function	Number of SPTH	Equivalent (feet)[1]
Large Woody Debris	1.0	200
Shade	0.75	150
Sediment Control	1.0	200
Bank Stabilization	0.5	100
Organic Litter	0.5	100
Microclimate	up to 3	up to 600

1 Note that this is based on a 200-feet SPTH (or that expected on a Class I site), and that equivalent functionality may be achieved by narrower buffers on sites having a narrower SPTH.

Figure 4. Riparian Forest Effects on Streams as a Function of Buffer Widths (from FEMAT 1993)



As specified in WDNR Forest and Fish Report (1999, 2003), SPTH has been determined for different stream site classes in western and eastern Washington (Table 2-5). Site classes are based on soil conditions and range from the most productive to the least productive sites (Evans and Fibich 1987). It has been determined that the most productive sites (Site Class I) in Western Washington would have a SPTH of 200 feet and the least productive sites (Site Class V) would have a SPTH of 90 feet. Based on these site potentials and stream size, riparian buffer prescriptions have been developed that are most applicable to forested lands. Differences in stream size for a given site class are used to further modify prescribed buffer dimensions within the overall riparian management zone ([RMZ] which is equivalent in width to the SPTH) so that different portions of the buffer (core, inner, and outer areas) have different dimensions to provide appropriate levels of protection (Table 2-5).

Many effects of riparian vegetation on streams decrease with increasing distance from the streambank (VanSickle and Gregory 1990; McDade et al. 1990; Beschta et al. 1987) (Figure 4) and are influenced by the degree of channel constraint and floodplain development (Sparks et al. 1990; Sedell et al. 1989).

Table 2-5. Example of Riparian Buffer Width Prescriptions from WDNR (2003)

Site class	RMZ/SPTH[1] width	Core zone width (measured from outer edge of the bankfull width or CMZ, whichever is greater)	Inner zone width (measured from outer edge of core zone)		Outer zone width (measured from outer edge of inner zone)	
			Stream width ≤10 feet	Stream width >10 feet	Stream width ≤10 feet	Stream width >10 feet
I	200	50	83	100	67	50
II	170	50	63	78	57	42
III	140	50	43	55	47	35
IV	110	50	23	33	37	27
V	90	50	10	18	30	22

1 The RMZ defined in WDNR (1999, 2003) is equivalent to the SPTH that has been determined for different site classes

Riparian functions and concepts covered in the following text include:

- Channel migration zones
- LWD recruitment
- Stream shading/temperature
- Bank stabilization/habitat formation
- Filtering of sediment, nutrients and chemicals
- Organic input and nutrient source
- Microclimate

Though the following discussion is primarily focused on stream habitats, additional discussion of how riparian vegetation influences lake shorelines is included where appropriate.

2.2.1 Channel Migration Zones (CMZ)

The importance of protecting the CMZ is well-documented, and to protect habitat functions supported by the CMZ, many investigators recommend that riparian buffers be measured laterally from the edge of CMZs where they occur, rather than from the ordinary high water mark (OHWM) as is typically required by existing code regulations (Knutson and Naef 1997; May 2000; WDNR 1999, 2003; Smith 2002). Knutson and Naef (1997) state "the channels of some streams, particularly larger streams and rivers in broad, alluvial valleys, may migrate across the valley as a result of natural erosional and depositional processes; the area over which the channel is expected to migrate is called the channel migration zone". As stream channels migrate across valley bottoms, riparian vegetation interacts with natural erosional and depositional processes, which promotes floodplain connectivity, LWD recruitment potential and the formation of instream habitat (May 2000).

From a regulatory standpoint, the definition of CMZs varies. The Washington Forest Practices Board (WDNR 1999) defined CMZs as "...the area that streams have recently occupied (in the last few years or less often decades), and would reasonably be expected to occupy again in the near future." However, the Forests and Fish Report (WDNR 1999) provide the following guidance for defining CMZs:

> "Operationally, the CMZ should be equivalent to the area that a stream is expected to occupy in the time period it takes to grow a tree of sufficient size to provide geomorphic/ecological functions in the channel. On smaller streams, it may be appropriate to be concerned where the stream could move within 100 years or less. However, larger wood is needed to function in larger, high-energy channels. To be functional, recruitment trees must be very large, with root wads attached. As a consequence, on a larger stream, it may be necessary to include areas in the CMZ that the stream could occupy in the next 200 years or more."

Regardless of the time frame used to define a CMZ, what ultimately determines the presence of a CMZ is physical evidence of channel migration such as inactive channels, old meander bends, sloughs, oxbows, or floodplain terraces. By definition, such features only occur within CMZs and any classification system of channel migration potential can only be derived from such evidence of channel migration. In general though, channel migration can be expected to occur in lower gradient streams and rivers having broad valleys (that were often formed by such channel migration processes over long periods of time), which are typical of those reaches designated as "Shorelines of the State" (i.e. having a mean annual flow ≥ 20 cubic feet per second [cfs]) in Lewis County. However, CMZs often occur in smaller streams and reach specific delineations, which are currently ongoing in Lewis County, must be conducted to determine the presence and extent of CMZs. Additional details and protocols for identifying and delineating CMZs is provided by WDNR (2003).

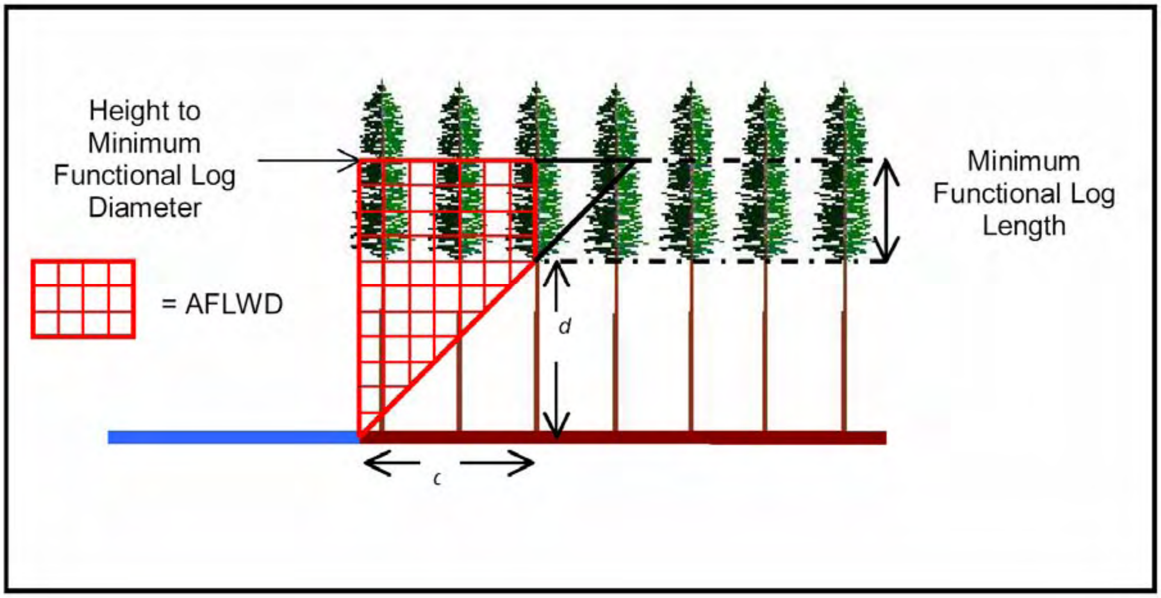
2.2.2 LWD Recruitment

LWD in streams influences coarse sediment storage, creates hydraulic heterogeneity, moderates flow disturbances, provides cover, and contributes to overall channel complexity. LWD traps and accumulates sediment, small woody debris, and other organic matter (Bilby 1981). The complex, submerged structure formed by LWD and entrapped smaller woody debris provides flow refugia and essential cover in which salmonids conceal themselves from predators and competitors and find profitable feeding positions, as inferred from observations under both natural and laboratory conditions (McMahon and Hartman 1989; Fausch 1984). The removal of riparian forest reduces woody debris in streams, which in turn leads to adverse changes in channel and habitat-forming processes (Bilby 1984; Heifetz et al. 1986; McDade et al. 1990; Van Sickle and Gregory 1990; Bilby and Ward 1991).

Riparian buffer widths of 100 to 200 feet (equal to about 1 SPTH) generally provide adequate LWD recruitment potential, depending on site conditions such as stream size, channel confinement, gradient, and buffer vegetation characteristics (i.e. type, maturity, and density) (Murphy and Koski 1989; Robison and Beschta 1990; McDade et al. 1990; Thomas et al. 1993). With respect to stream size, the role of LWD varies, with riparian vegetation generally exerting a greater influence on smaller streams (Knutson and Naef 1997). Large woody debris (LWD) is not easily transported in small streams, regardless of gradient, thus individual pieces (logs, root wads, etc) can greatly influence channel morphology, instream cover, food resources, and sediment transport.

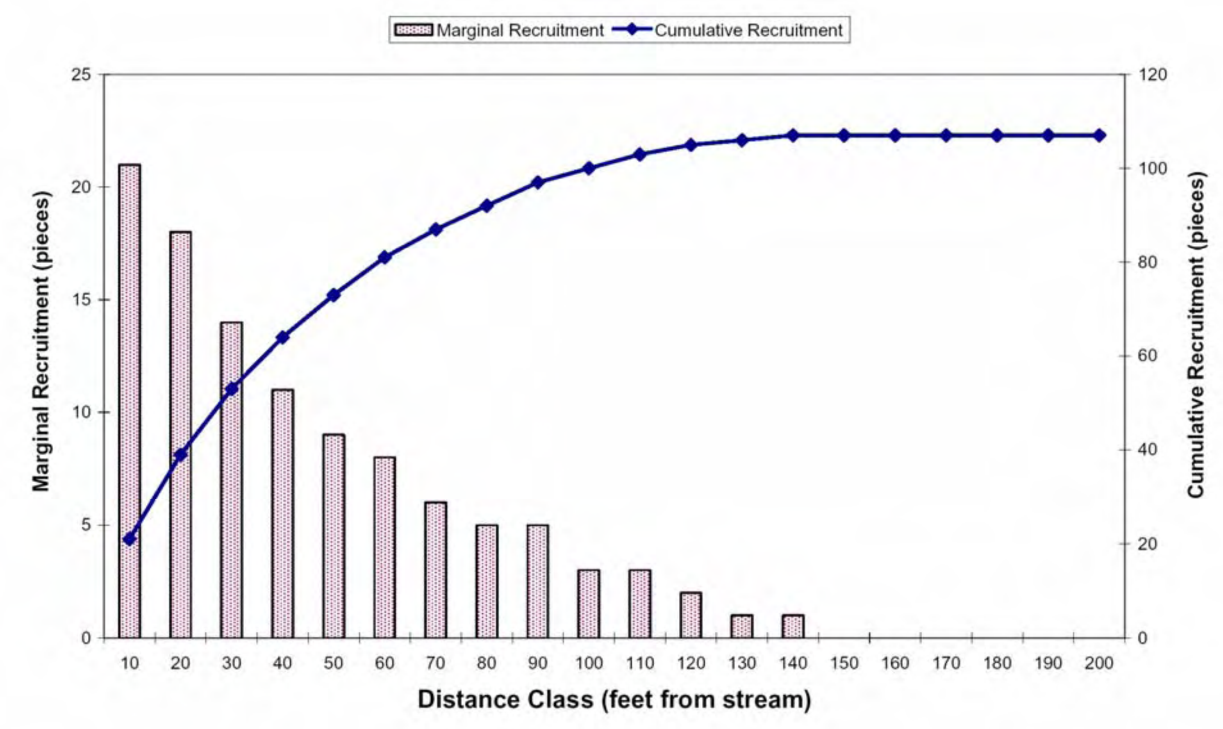
The influence of buffer size on LWD recruitment is a physical function of the size of trees and the distance from the stream as well as slope. As illustrated in Figures 5 and 6, the portion of a tree available to be recruited into a stream decreases as the tree's distance from the stream increases. For that reason, the area closer to the stream provides a relatively greater proportion of the total LWD recruited. McDade et al. (1990) found that more than 70 percent of the woody debris (pieces) originated within 20 meters of the channel in mature and old-growth forests of western Oregon and Washington. This relationship, however does not illustrate the importance of total stand density (the number of trees per acre) as well as the size of trees and the resulting size of individual pieces of LWD recruited.

Figure 5. Schematic of Tree Height in Relation to LWD Recruitment.



Source: Lewis County 2006

Figure 6. LWD Recruitment as a Function of Distance from Stream



Source: RTI 2001

As stream size increases, the influence of riparian vegetation and individual pieces of LWD decreases, and more substantial logjams are needed to affect instream structural complexity, as was characteristic of the historic Cowlitz River (WSCC 2000). Larger buffer widths (>200 feet) may be required for long-term natural recruitment of woody material (FEMAT 1993; May 2000). Humans can "import" woody debris to streams and rivers, but these artificial recruitment efforts provide limited short-term, benefits to stream habitat (e.g., fish cover, localized hydraulic complexity). While human installation of LWD is not an adequate substitute for the natural recruitment potential of healthy riparian areas and does it provide many other important long-term benefits provided by native vegetation buffers, artificially introduced LWD can provide some habitat benefits in the absence of riparian buffers and natural recruitment (e.g. highly managed agricultural areas), or as an interim measure while existing or newly established riparian buffers mature.

2.2.3 Shading and Temperature

As was reviewed in GEI (2002), thermal modeling results indicate that stream temperature in any given location is primarily dependent on the temperature of water directly upstream, or the input water temperature. Riparian vegetation generally serves to reduce solar heating and maintain water temperatures. Under undisturbed conditions, stream temperatures are maintained because the surface and groundwaters that comprise streamflow are thermally protected by upland and riparian vegetation and soils. As forested area in a watershed is removed, thermal protection is removed and the ratio of surface-to-groundwater in a stream increases. Combined with loss of thermal protection, stream temperatures increase. Therefore, actions in upper watersheds can lead to increased water temperatures in lowland areas, but adequate shading is required in lowland areas to prevent further solar heating.

The value of riparian buffers in moderating stream temperatures is well-established, but the effectiveness of different buffer widths varies depending on site conditions. Beschta et al. 1987 has concluded that buffer strip widths of 100 feet or more generally provide the same level of shading as that of old growth forest in the Pacific Northwest while other authors have recommended a minimum buffer width of 30 feet (Davies and Nelson 1994). In forested areas, harvest treatments that leave overstory vegetation buffers adjacent to streams have been shown to have no significant impact on stream temperature (Lee and Samuel 1976; Rishel et al. 1982; Lynch et al. 1984; Sugimoto et al. 1997). In coastal British Columbia, Gomi et al. (2003) conducted a 6-year field experiment to evaluate the effects of riparian buffer widths on stream and riparian ecosystems, including stream temperature response. Treatments included no timber harvesting, harvesting with 33-feet and 100-feet wide riparian buffers, and clear-cut harvesting with no buffer. The results indicated that water temperature in the streams with 33 -feet and 100-feet wooded buffers did not exhibit statistically significant warming. Todd (2000) examined various buffer functions and found that smaller riparian buffers (as narrow as about 40 feet) are required to protect water temperature and food web functions, and Johnson and Ryba (1992) recommend a similar buffer width of from 30 to 100 feet to effectively protect stream temperature. However, Brown and Kryier (1971) noted that on very small streams, adequate shade may be provided by brush species.

Along lake shorelines, shading from vegetation reduces light levels and helps regulate heating of the nearshore areas or the upper intertidal zone. Shading also reduces mortality and stress to insects and aquatic invertebrates, which serve as forage species for salmonids. Juvenile anadromous salmonids rely upon shallow-water habitats while migrating through lakes, especially those vegetated with algae and macrophytes, for prey resources and shelter from predation (Tabor et al. 2004).

2.2.4 Bank Stabilization and Habitat Formation

Streams tend to erode the outer banks of meander bends while depositing sediment as bars on the inside of the meander bends. Through this continual process of erosion and deposition, the location and quality of habitats and the meander pattern and position within the valley changes over time. This process acts in response to natural and unnatural disturbances within a watershed and serves to create and recreate salmonid habitat. For any given disturbance, the rate, magnitude, and nature of channel response in part depends on the condition of riparian vegetation.

Vegetation resists shoreline erosion, but often not as effectively as artificial structures. Diverse native vegetation can be expected to moderately resist shoreline erosion allowing channels to physically respond to disturbances, thereby forming and reforming salmonid habitat features over time (Reeves et al. 1995). As reviewed in Spence et al. (1996), roots bind streambank soils and slow water currents, thereby stabilizing stream banks. Stream currents carve the material underneath the root zone creating shelter and structural habitat for salmonids and terrestrial and aquatic macroinvertebrates that support fish populations. Other benefits of the natural channel formation and migration process include erosion of gravels from streambanks, which replenishes spawning substrate, and the undercutting of streamside trees, which become a primary source of LWD.

In many areas of the populated and developed lowland areas of Lewis County, natural channel formation processes have been interrupted by armoring streambanks with berms, dikes, artificial structures such as rock-riprap, concrete bulkheads, or steel sheet-piling to protect lives and property. This interruption of channel-forming processes may be necessary and permanent, but it must be acknowledged in such cases that complete resistance to shoreline erosion does not support reliance on natural habitat forming processes, and other means of providing habitat features, if possible, would be necessary.

As concluded in FEMAT (1993), an appropriate width for providing bank stabilization is 0.5 SPTH (see Table 2-4). Based on this criterion, this distance will vary depending on site conditions, but would be expected to range from about 50 to 100 feet. While relatively narrow buffers of immature vegetation may provide adequate bank stabilization, particularly in low-gradient reaches of smaller streams, other studies recommend a width of about 100 feet as generally sufficient to control streambank erosion, even in areas of high mass wasting (Knutson and Naef 1997; May 2000; Cederholm 1994).

2.2.5 Filtering of Sediment, Nutrients and Chemicals

Uptake of dissolved chemicals, and filtration of sediments from overland-runoff and flood water is an important riparian function (Cummins et al. 1994). The chemicals that constitute plant nutrients may be largely incorporated in the riparian zone's biomass. This combined with the trapping of sediment within the riparian landscape contributes to the building of "new land" involved in channel or shoreline migration. Any action, such as clearing, that degrades the integrity of the riparian zone will hamper to some degree these chemical filtering, uptake and land-building functions.

Literature analysis by FEMAT (1993) indicate that healthy riparian zones greater 200 feet from the edge of a floodplain probably remove most sediment from overland flow. Sufficiency of buffer widths is dependent on slope steepness, with wider buffers required for steeper slopes (Vanderholm and Dickey 1978). Given this, widths of 100 to 300 feet appear to be generally sufficient for filtering substantial proportions of sediment (50 to 90 percent) originating from hill slopes (Karr and Schlosser 1977; Johnson and Ryba 1992; Belt et al. 1992; Lowrance et al. 1986, 1988). While these recommendations are based mainly on short-tem studies, some long-term studies have been conducted that also support a recommended buffer width of 100 to 300 feet for filtering sediment (Lowrance et al. 1986, 1988).

Buffer widths reported for removal of pollutants, nutrients and chemicals can vary widely based on vegetation type, soil type, and slope. Knutson and Naef (1997) report that buffer widths ranging from 13 feet to more than 850 feet are adequate for nutrient reduction or removal depending on site conditions. Though there is a wide range of effective buffer widths reported in the literature, widths of 100 feet are generally sufficient for removing nutrient or bacterial pollution (Lynch et al. 1985; Terrell and Perfetti 1989). Terrell and Perfetti (1989) also report riparian widths of 200 and 600 feet as necessary for removing pesticides and animal waste and nutrients from croplands.

But numerous studies reported in GEI (2002) illustrate that significant sediment filtering and water quality benefits can be achieved in agricultural areas (generally low-gradient systems with little side-slope) by buffers or vegetation filter strips ranging from 25 to 50 feet, particularly in combination with suitable best management practices (BMPs). If buffers are the primary means of protection against input of sediments, nutrients, pesticides and pathogens, then relatively wide buffers may be required. However, by employing appropriate BMPs such as sediment controls, and managing the application of fertilizer and pesticides the risk of transport into streams can be markedly reduced, thereby reducing the riparian buffer width required to effectively protect streams from these impacts.

2.2.6 Organic Input and Nutrient Source

Riparian trees and other vegetation furnish fresh waters with a "litter fall" of plant particles (leaves, pollen grains, etc.), and with terrestrial insects. These organic materials compose a major energy source for food webs that sustain production of salmonids, particularly in low- and mid-order streams (Gregory et al. 1991; Naiman et al. 1992; Cummins et al. 1994). Along small stream channels, outside sources of nutrients such as litter fall from healthy stands of riparian vegetation is a greater contributor to the aquatic food web than in-channel algae production, which tends to predominate as the basis in wider, less shaded streams (Vannote et al. 1980) and in standing waters. Clearing riparian vegetation may reduce or destroy the nutrient-providing function depending on the extent of the action and the relative importance of litter fall in sustaining nutrient input into the system.

2.2.7 Microclimate

Microclimate, defined as the local climate (humidity, wind speed, and air temperature) within the stream-riparian ecosystem, is primarily affected by the quality and extent of riparian vegetation (Pollack and Kennard 1998). Watershed scale microclimate also influences stream temperatures, contributing to lower temperatures in forested watersheds than in urbanized or otherwise cleared watersheds. Brosofske et al. (1997) documented that riparian microclimate is important to consider in management because it affects plant growth, therefore influencing ecosystem processes such as decomposition, nutrient cycling, plant succession, and plant productivity. Thus microclimate alterations can affect structure of the riparian forest, the waters within it, and the well-being of many animals, including fish. Riparian buffer widths necessary for microclimate control are generally much wider than those necessary for other functions, with the exception of habitat for some wildlife species. A riparian buffer width of 200 feet may provide minimum or partial microclimate function in some circumstances; however, widths greater than 300 feet are generally required to provide full microclimate protection (Spence et al. 1996; Chen et al. 1990; Brosofke et al. 1997; Franklin and Forman 1987).

2.2.8 Hydrologic Regime

Within streams, both the physical (severe erosion and flooding) and biological (loss of species productivity and diversity) effects of development tend to be more pronounced in heavily urbanized areas with considerable impervious surfaces, but they can also occur in relatively rural areas (Booth and Reinelt 1993; Booth and Jackson 1997; May et al. 1997; Booth and Henshaw 2001). These effects are primarily due to alteration of the hydrologic regime due to increases in impervious surface area, loss of natural forest infiltration capacity, and modification of the stream drainage network resulting in increased peak discharge magnitude and frequency (Booth 1990; Booth and Reinelt 1993; Booth and Jackson 1997; Horner and May 1999; Booth et al. 2002). These effects can have serious negative impacts on salmonids and instream habitat (May et al. 1997).

Recent research models developed in the Pacific Northwest suggest that a threshold for urban stream stability exists at about 10 to 15 percent imperviousness and found that when effective impervious area in a watershed exceeds this threshold, a demonstrable, and probably irreversible, loss of aquatic system function occurs in western Washington streams (Booth 1991; Booth and Reinelt 1993).

2.2.9 Lakes and Ponds

Lakes and ponds have similar functions related to aquatic species as streams, but with important differences related to their structure and place in the ecological structure. For the purpose of this discussion, aquatic areas of lakes include three distinct zones of biological communities: a limnectic zone, a littoral zone, and a benthic zone. These three distinct zones or habitats are coupled by biological, physical, and chemical processes (Schindler and Scheuerell 2002).

The limnectic (pelagic) zone is the open water area where light does not penetrate to the bottom. Typically, the pelagic habitats of lakes are inhabited by microscopic bacteria, viruses, protozoa, phytoplankton, zooplankton, planktonic life-stages of insects, and fishes (Schindler and Scheuerell 2002).

The littoral zone (including the fringe area) is the near-shore area where sunlight penetrates all the way to the sediment and allows aquatic plants to grow. The extent of this area depends on the physical dimensions of the lake basin lake as well as the water clarity on any given day. Trees and LWD in the littoral zone provide a food source and a substrate for algae and invertebrates (Schindler and Scheuerell 2002), as well as habitat for fish and other organisms (Piaskowski and Tabor 2001; Tabor and Piaskowski 2002). The littoral zone is of great importance to fish species, particularly anadromous species such as salmon. It provides migration corridors, spawning habitat, and rearing habitat for salmonid species (Buckley 1964; Berge and Higgins 2003; Fresh 2000; Piaskowski and Tabor 2001; Tabor and Piaskowski 2002). In addition, the littoral zone can provide habitat for insects such as dragonflies (*Odonata*), mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), caddis flies (*Trichoptera*), and midges (*Diptera*) important as food for a variety of aquatic species..

The benthic zone occurs in the lake bottom. The term benthic applies to flora and fauna living at the lake bottom and those species that live by burrowing in the lake bottom. Benthic organisms can live in the substrate (in mud and sand), move on the substrate surface, and/or grow attached to the surface. Typically, much of the lake bottom beyond the littoral zone is covered with mud, with particle size and organic content depending on conditions specific to a lake.

The focus of this discussion is on the lake littoral zone, particularly its importance to anadromous fish species, such as salmon.

Lakes and lake shorelines support numerous ecological functions related to aquatic and riparian habitat, flood control, and water quality, as well as human values such as economic resources and recreation. Ecological functions are related to complex physical, chemical, and biological processes at work within the overall landscape. In lakes, these processes take place within an integrated ecosystem of aquatic and riparian habitats (Schindler and Scheuerell 2002).

Ecological function refers to the work performed or role played by the physical, chemical, and biological processes that contribute to the maintenance of the aquatic and terrestrial environments and includes the following:

- **Hydrologic functions**: Storing water and sediments, attenuating wave energy, removing excessive nutrients and toxic compounds, and recruiting LWD and other organic material.
- **Shoreline vegetation functions**: Maintaining temperature, removing excessive nutrients and toxic compounds, attenuating wave energy, removing sediments, stabilizing shorelines, and providing woody debris and other organic matter.
- **Hyporheic functions**: Removing excessive nutrients and toxic compounds; providing water storage, supporting vegetation, and storing sediment; maintaining base flows.
- **Habitat functions** (pertaining to aquatic and shoreline-dependent birds, invertebrates, mammals; amphibians; and anadromous and resident native fish): Providing space or conditions for reproduction, resting, hiding, and migration; and providing food production and delivery.

Lake shorelines can provide the following ecological functions, particularly in remnant natural unarmored areas (Tri-County Salmon Conservation Coalition 2002; Tabor and Piaskowski 2002; Piaskowski and Tabor 2001):

- **Flood attenuation and water quality improvement**: Rain that runs off the land can be slowed and infiltrated in the riparian area, which helps settle out sediment, nutrients and other pollutants before they reach lake waters. In addition, nutrients from fertilizers and animal waste that originate on land are taken up by tree roots. Phosphorus and nitrogen are stored in leaves, limbs, and roots instead of reaching the lakes.
- **Sediment trapping** (emergent vegetation in the littoral fringe).
- **Nutrient cycling**.
- **Substrate**:
  - Growth medium for aquatic (submerged) vegetation.
  - Habitat for macroinvertebrates and fish.
  - Sand provides rearing habitat for juvenile Chinook salmon.
  - Gravel provides spawning habitat for sockeye and kokanee salmon.
- **Shoreline vegetation buffers** provide a number of functions including:
  - Canopy and shade: Shading by lake vegetation can moderate water temperature along the shoreline fringe area providing relief for aquatic life in the hot summer months.
  - **Organic matter input** (riparian vegetation and LWD): Leaves and woody debris fall into the lakes and provide food and habitat for fish and other aquatic species that are critical to the aquatic food chain.
  - **Shoreline erosion protection** (from remnant natural unarmored areas): Tree roots hold the shoreline soils together and tree stems protect the shoreline by deflecting the cutting action of waves, boat wakes, and stormwater runoff.
  - **Water quality improvement**: Rain that runs off the land can be slowed and infiltrated in the adjacent riparian upland and wetland areas, which helps settle out sediment, nutrients and

other pollutants before they reach lake waters. In addition, nutrients from fertilizers and animal waste that originate on land are taken up by the roots of diverse vegetation.

- **Wildlife support and refugia**: Shoreline riparian areas, particularly natural unarmored areas, offer habitat for a range of wildlife species.
  - Adult salmon migration corridor and holding habitat.
  - Sockeye and kokanee salmon spawning substrate.
  - Juvenile salmon rearing habitat and migration corridor.
  - Salmonid rearing habitat.
  - Cutthroat trout and warm-water fish habitat.
  - Food for bird species.

Not all of these functions are provided by every lake; indeed, many lakes, particularly in urbanized areas, can provide only a few of the functions listed above. Nevertheless, the list above highlights the range of potential ecological functions of lakes.

2.3 HUMAN ACTIVITY AND AQUATIC HABITAT FUNCTIONS

Puget Sound streams and rivers once flowed through dense forested areas and broad vegetated floodplains. These streams had natural flow regimes, excellent water quality, and complex instream cover. Today, healthy riparian areas are scarce or inadequate, and streams and rivers are frequently confined or controlled, or are realigned to accommodate agricultural or development activities. Human activities have had similar effects on nearshore and estuarine habitats. The effects of human activities on aquatic habitats are summarized in Table 2-6.

Table 2-6. General effects of Different Human Activities on Aquatic Habitats

Activities	Effects
Removing riparian vegetation	Reduced channel complexity, simplified channel morphology, increased stream velocities, loss of pools for holding and rearing, loss of spawning gravel, loss of side channels, loss of wood recruitment, loss of connectivity with floodplain and riparian zone, reduced shade and cover; increased solar radiation; increased erosion and sedimentation, elevated water temperatures and reduced leaf litter.
Introducing invasive non-native vegetation	Altering native riparian habitat functions including associated wildlife refuge, insect litter, replacement of coniferous shade producing trees, etc.
Creating impervious surfaces, filling and draining of wetlands, and increasing water allocations	Altered flow regimes (timing and magnitude of flows), degraded water quality/increased stream temperatures, increased stormwater runoff, and altered instream habitat.
Streambank modifications	Loss of natural meander/habitat-forming processes, disconnected floodplains and subsequent loss of floodplain processes.
Discharging sewage effluent	Degraded water quality, altered water temperatures, reduced dissolved oxygen concentrations, and increased contaminant levels.
Agricultural runoff	Degraded water quality including increased nitrogen and fecal coliform, and reduced dissolved oxygen levels.
Livestock access	Degraded water quality, loss of riparian vegetation, streambank instability.
Constructing culverts, pipes, and ditches	Obstructed upstream passage of fish and reducing the downstream movement of wood and gravel.

Table 2-6. General effects of Different Human Activities on Aquatic Habitats (continued)

Activities	Effects
Filling/altering estuarine and nearshore habitats	Reduced availability of freshwater to saltwater smolt transition habitat (including cover and food production), and staging and holding habitats for adult salmon.
Constructing bulkheads and docks	Increased habitat for predators, altered nearshore currents and gravel movement.
Construction activities	Increased erosion, turbidity and inputs of fine sediment during construction and prior to revegetation.
Recreational activities	Degraded water quality, and increased contact with listed species.

2.3.1 Freshwater Riverine Habitats

As presented in the WRIA 23 and 26 Limiting Factors Analyses (WSCC 2000, 2001), riparian and floodplain conditions have been substantially altered throughout the Chehalis and Cowlitz basins. Forestry is the dominant land use in the Cowlitz basin, with over 70 percent of the land managed as public and private commercial forestland. Much of the private land in the river valleys is agricultural and residential, resulting in substantial impacts to riparian and floodplain areas in places.

The upper portion of the Cowlitz River Basin includes the Cispus subbasin, Upper Mainstem Cowlitz subbasin, and many headwater tributaries. These areas have a substantial amount of land in non-commercial and reserved forest, owing primarily to the large public land holdings (Gifford Pinchot National Forest and Mt. Rainier National Park) in the basin. These lands are heavily forested with relatively intact landscape conditions that support functioning watershed processes. Functional riparian conditions are located along the higher elevation streams in the upper Cispus and upper Cowlitz mainstem basins, with relatively unaltered streams, low road densities, and riparian areas and uplands characterized by mature forests. Existing legal designations and management policy are expected to continue to offer protection to these lands.

Riparian conditions in the middle portion of the Cowlitz Basin (in the vicinity of Mayfield and Riffe Lakes) are substantially degraded. The greatest impairments are in the Mayfield Lake and Rainey Creek basins. Over 87 percent of riparian corridors in the Mayfield /Tilton basin are clearly lacking vegetation or have early-seral riparian conditions (Lewis County GIS 2000). Stream surveys revealed that the mainstem Tilton, East Fork Tilton, South Fork Tilton, and Lake Creek all had greater than 60 percent of surveyed habitat units with only 0 to 20 percent canopy cover (Harza 1997).

In the lower Cowlitz Basin (downstream of Mayfield dam to the Lewis County border), agriculture and forestry activities have impacted riparian areas (WSCC 2000). Riparian forests on the Cowlitz River in this area lack mature forests and adequate buffer widths (WSCC 2000). An aerial photo analysis on this reach reveals that coniferous cover types currently make up less of the riparian forest than they did historically. Gravel bars currently have more vegetative cover compared to conditions in 1939, possibly due to reduction of flood flows by upstream dams. Another change since 1939 is a decrease in the meadow/grasslands cover type, likely related to current agriculture, shrub encroachment, and residential uses (Harza 2000). Although floodplain connection is generally properly functioning, there are scattered areas with bank revetments. In addition, channel incision, diking, dredging, bank hardening, and various types of development have disconnected floodplains from channels in several tributaries to this reach.

Forests encompass approximately 85 percent of the entire Chehalis River drainage, of which 66 percent are privately owned forests (CRC 1992; Pickett 1992). Agricultural activities dominate the valleys, while timber management occurs throughout most of the upland areas. The lower Chehalis Basin (downstream of Porter) consists of 91 percent forest, while the upper Chehalis is 77 percent forest. Agricultural activities account for 10 percent of the basin's land use, and the remainder is urban and industrial lands, mostly concentrated in Centralia and Chehalis (Pickett 1992).

The mainstem Chehalis River has severe impacts from channel incision, sedimentation, riparian loss or conversion, water quality problems, and reduction in stream flow; many of these problems are translated to the mainstem Chehalis River from tributaries. The causes of channel incision are not well defined. In the upper Chehalis, debris torrents have led to incision. Downstream, potential causes of incision include increased sediment transport due to increased sediment loads from tributaries coupled with an extensive loss of LWD. Also, increased peak flows due to urbanization and changes in landcover vegetation are other suspected causes. While local bank erosion is common along the mainstem, large sediment loads enter the mainstem Chehalis from the tributaries. In order of contribution, those that contribute the most sediment are the Newaukum, South Fork Chehalis, and upper Chehalis subbasins. To address sediment problems in the mainstem, actions must occur in those sub-basins. There has also been an extensive loss of riparian vegetation along the mainstem, coupled with conversion of conifer to hardwoods. This contributes to bank erosion, warm water temperatures, and lack of LWD. The causes of riparian loss to the mainstem are mainly agriculture and urbanization.

The headwaters for the mainstem Chehalis River are in the eastern Willapa Hills where the land use is predominately (77 percent) forestry. As the mainstem flows through the areas of Pe Ell and Doty, the land use adjacent to the mainstem is dominated by agriculture. Urban and industrial use predominates as the mainstem flows through the Centralia and Chehalis area. The channel is deeply cut with very little spawning habitat, as the streambed consists of sands. A very low gradient of less than 1 foot per mile exists just upstream of the Skookumchuck confluence (USACE 2000). Downstream of Centralia, the land use surrounding the Chehalis River mainstem is again dominated by agriculture. Near Scatter Creek, the mainstem flows through an area of low prairie land that has experienced heavy residential growth.

Using a model to evaluate estimated existing shade compared to natural conditions, the two most degraded sites are the mainstem Chehalis between Newaukum River and the Skookumchuck River (168 percent change between current and natural shade) and the mainstem between the Skookumchuck River and Scatter Creek (144 percent shade change) (WSCC 2001).

Water quality is also limiting factor for salmonid production in the Chehalis River (WSCC 2001). From Scammon Creek to Newaukum River, causes of water quality impairment include urban stormwater, food processing plants, and in the upstream section, dairies (Jennings and Pickett 2000). From the Newaukum River to Rock Creek, the primary cause is livestock waste (dairies). In the reach from Rock Creek to the East and West Fork confluence, causes include livestock waste and sewage discharge from Pe Ell (Jennings and Pickett 2000). The U.S. Environmental Protection Agency (EPA) Total Maximum Daily Loads program (TMDL) states that the highest priority in restoring dissolved oxygen levels is to eliminate pollution from large-scale commercial livestock operations (WSCC 2001).

To effectively address these impacts to aquatic habitats, it is necessary to prioritize management strategies based on habitat needs. WSCC (2000, 2001) describes the condition of habitat features and limiting factors of streams and rivers throughout WRIAs 23 and 26, and the analysis of limiting factors is a necessary step in defining management priorities. But it should be stressed that prioritization of habitat and restoration needs is dependent not only on existing habitat conditions and current species use, but also on the expectations and potential for conservation or restoration given the entire suite of existing and anticipated land uses. Of particular concern are human alterations that result in shoreline hardening through revetments and other protective measures designed to restrict stream movement and natural erosion patterns. Adverse effects of such measures typically affect a number of ecological functions, including.

- Restriction of channel movement changes the geomorphic processes of steam formation and maintenance. Hardened shorelines along rivers slow the movement of channels, which, in turn, alters the input of larger woody debris, gravels for spawning, and the creation of side channels important for numerous species, including juvenile salmon rearing, and can result in increased floods and scour. (Bottom1985).
- Vegetation that shades the bank is eliminated, thus degrading the value of the shoreline for many ecological functions, including temperature attenuation critical to spawning habitat for a variety of species including salmonids. Large woody debris recruitment may be diminished, depending on the scale of the structure. (Hall 1984).
- Ground water impacts can result from separation of the stream from interflow from groundwater and may affect recharge, low flows and temperature. Erosion control structures often raise the water (Fischenich, 2002)

Additionally, hard structures, especially vertical walls, often create conditions that lead to failure of the structure. In time, the location of revetments or other structures can cause migration of the channel downstream that may result in scouring, undermining and failure. (Mussetter 1983).

2.3.2 Lake Shoreline Alterations

The ecological functions of lakes (Section 2.2.9) may be impaired by a variety of human actions. Shoreline modifications, for example, can have a variety of effects on lake function. Such modifications may include those that change physical configuration through the construction of physical structures such as bulkheads, breakwaters, jetties, groins, docks, and piers, as well as vegetation modification including clearing native vegetation and replacement with agricultural or ornamental vegetation.

The effects of bulkhead structures have been broadly studied in marine environments, particularly when used as the means to armor the shoreline for protection against wave-induced erosion. In contrast, relatively few studies have addressed the environmental effects of these structures in freshwater environments (Carrasquero 2001). Among the variety of functions described in Section 2.2.9, bulkheads have the greatest effect on aquatic and riparian habitat and associated species, particularly salmonids.

The removal and modification of riparian and aquatic vegetation, placement of the bulkhead structure and associated fill and removal of woody debris have the following effects:

1) loss of organic input (e.g., tree litter, large woody debris, insects) within the lake's littoral zone;

2) loss of shade and temperature attenuation provided by large vegetation;

3) displacement of physical aquatic and terrestrial habitat;

4) habitat alteration due to changes in wave action and other processes; and

5) loss of sediment input as well as changes to lateral transport of sediment along the shoreline and resulting patterns of deposition.

The response of aquatic species may include changes in the food web, changes in fish spawning and rearing habitat as well as migration patterns, and alteration of predator-prey interactions. Following is a brief discussion of each of these habitat and species responses.

2.3.2.1 Loss of Organic Input

Structural shoreline stabilization in lakes generally results in vegetation removal and displacement or alteration of aquatic and riparian habitat (Carrasquero 2001; Kahler et al. 2001). Vegetation removal results in a reduction in organic input including tree litter, LWD, and insects. Results of such changes include the loss of insects as a food sources for fish species that inhabit the lakes, and the loss of and LWD that provides habitat structure (Tabor et al. 2004a and 2004b; Piaskowski and Tabor 2002). Bulkheads permanently alter the margins of lake ecosystems that directly contribute to the food web through leaf litter and insects falling into the water from overhanging vegetation (USACE et al. 2001).

In addition, the construction of bulkheads contributes to alteration of the natural shoreline configuration and physical habitat through straightening, reducing the perimeter-to-area ratio as well as the complexity and variety of habitat. Lakes with a high degree of shoreline convolution have stronger ties to riparian habitats because of the increased perimeter-to-area ratio (Gasith and Hasler 1976; Scheuerell and Schindler 2004).

Bulkheads also remove existing coarse woody debris and shoreline vegetation, thereby reducing refuge habitat for fish. For example, recent surveys performed in Lake Sammamish in King County indicate that shoreline areas with woody debris and overhanging vegetation have a higher overall density of Chinook and coho salmon than open sites. In February and March, juvenile Chinook salmon in Lake Sammamish appear to use woody debris during the day but as they grow, the use decreases. In May and June, woody debris is not used extensively but may still serve as a refuge from predators (Tabor and Piaskowski 2002). Coho salmon have a much stronger affinity with woody debris during the day, compared to Chinook salmon. At night, coho salmon inhabit open sites and are not closely associated with woody debris or overhanging vegetation. In addition, this daily and seasonal variation in habitat utilization by Chinook and coho salmon illustrates the importance of maintaining natural habitat diversity and complexity along lake shorelines.

2.3.2.2 Loss of Shade

The effect of loss of vegetation varies with lake size. In large, stratified lakes, water temperature is regulated more by air temperature and the temperature of tributaries than by microclimatic controls provided by surrounding riparian forests. However, streams and surface water runoff into these lakes can create localized temperature gradients. Hence, deforestation of riparian areas associated with stream tributaries likely adversely affects water temperature in large lakes.

Even on large lakes, riparian vegetation likely moderates summer water temperatures along the fringe area of the lake’s littoral zone and is influenced by the height, width, and species composition of adjacent riparian forests. In Lake Washington and Lake Sammamish, shoreline areas with overhanging vegetation have a higher overall density of Chinook salmon than do open sites (Tabor and Piaskowski 2002). Because Chinook salmon depend on the littoral zone’s fringe area, a loss of shade resulting in higher water temperatures is likely to adversely affect juvenile salmonid habitat utilization, and thus their survival. A reduction in abundance of overhanging vegetation may result in increased daily temperature fluctuation in the littoral zone due to loss of shade. Local areas of increased water temperature can result in temperature barriers that limit the range and survival of Chinook salmon and bull trout (Donald and Alger 1993).

2.3.2.3 Loss of Habitat

Christensen et al. (1996) studied 16 lakes with varying degrees of shoreline residential development in northern Wisconsin and Michigan's upper peninsula. They found a substantial reduction in the amount of course woody debris as the density of shoreland development increased. This occurs through two mechanisms: 1) direct removal of fallen tree trunks and branches from the lake and 2) removal of trees along the shoreline. The authors concluded that because of the time scales involved in both recruitment of coarse woody debris and decay rate, the reduction of coarse woody debris along the lakeshore may have dramatic long-term consequences for lake ecosystems.

A recent scientific study along Thurston County's marine shoreline demonstrated that shoreline bulkheads have reduced beach habitat areas through lowering of beach profile, reduction of sediment recruitment, coarsening of sediment in front of the bulkheads, and loss of riparian vegetation and LWD (Herrera 2004). Bulkheads constructed below the OHWM have the greatest impact on the littoral fringe as they eliminate shallow water area as well as the fringe area of the littoral zone. This habitat loss is likely to affect aquatic species that utilize these habitat types. Collins et al. (1995) compared fish use of fringe zones adjacent to lawns to use of undeveloped shorelines in Lake Rosseau, Ontario. They found shallow water to be critical for foraging, refuge, and migration of small fishes.

2.3.2.4 Loss of Sediment Input

Erosion of shorelines by wave action results in a continuous input of sediment. The sediment is occasionally supplemented by large sediment deposits from mass wasting. Sediment added to the system by erosion or slope failure is transported along the shore by wave energy, in the direction of prevailing winds (Burnett 1991; Lawrence and Davidson-Arnott 1997).

Shoreline areas that lack sediment supply are subject to increased erosion of existing beach substrate (Burnett, 1991; Lawrence and Davidson-Arnott 1997). Bulkheads potentially interrupt the process of sediment transport by preventing the input of sediment from the shore, increasing reflective wake energy, and by altering the movement of sediment along the shoreline.

Loss of sediment sources, particularly sand, is likely to affect nearshore fish habitat. A shallow sandy habitat type is preferred by juvenile Chinook salmon (Tabor and Piaskowski 2002; Piaskowski and Tabor 2001; Fresh 2000). In addition, sand-dominated stream deltas along the shorelines of large lakes are used by juvenile Chinook salmon (Tabor 2003; Tabor et al 2004b). Therefore, any reduction in sand supply to these shallow sandy areas or deltas is likely to affect this species.

In addition, loss of sediment supply, particularly gravel, is likely to affect spawning habitat of sockeye and kokanee salmon (and potentially Chinook salmon) in lake ecosystems. Sockeye, kokanee, and occasionally Chinook salmon spawn along some shoreline areas of some lakes in western Washington (Buckley 1964; Roberson 1967; Berge and Higgins 2003). Therefore, any reduction in the gravel supply to these shallow sandy areas or deltas is likely to affect spawning habitat necessary for these fish species.

2.3.2.5 Changes in Habitat and Utilization

A basic principle of ecology is that organisms respond to variation in the structure of the physical environment (Vannote et al. 1980; Minshall 1988). A study of Chinook salmon nocturnal habitat use in littoral areas Lake Washington found that at night, juvenile Chinook salmon avoid the steep and deep areas created by the bulkheads (Piaskowski and Tabor 2001)

Based on their distribution relative to predatory fishes, it appears that juvenile Chinook salmon in Lake Washington select littoral habitats according to the predation risk associated with the substrate and depth of a given location (Piaskowski and Tabor 2001). In this regard, it has been suggested that juvenile fish move offshore when they reach a size at which they are no longer vulnerable to most fish predators (Jackson 1961; Werner 1986). Consequently, an increase in substrate particle size and/or deepening of the littoral area (loss of shallow water habitat) caused by bulkheads is likely to affect juvenile Chinook salmon survival, both by eliminating their preferred habitat and migration corridor and by increasing their predation risk.

2.3.3 Docks and Overwater Construction

Docks, piers, boathouses, and floats alter the shore-zone habitat structure, promoting changes in plant and animal communities. These over-water structures can thereby affect the biological community and the environment by altering predator–prey relationships, fish behavior, or habitat function.

A literature review by Carrasquero (2001) presented the following observations and inferences:

- Smallmouth bass and largemouth bass have a strong affinity to structures, including piers, docks, and associated pilings.
- Bass have been observed foraging and spawning in the vicinity of docks, piers, and pilings.
- Smallmouth bass are opportunistic predators that consume prey items as they are encountered.
- Smallmouth bass are major predators on juvenile salmonids, likely due to the overlap in rearing habitat.

Several authors have documented the use of over-water structures by bass in western Washington waters. Stein (1970), examining the types of largemouth bass cover in Lake Washington, found that they prefer areas of heavy log and brush cover over other habitat types (including docks). Nevertheless, largemouth bass are commonly found under docks in early spring and are thought to be present there until late summer (Stein 1970). Additional supporting evidence on bass utilization of docks and piers associated with over-water structures comes from unpublished data. Biologists with the Washington Department of Fish and Wildlife found that in local lakes, bass preferentially use natural structures, but are also found associated with docks (Kahler et al. 2001). Also, biologists with the Muckleshoot Indian Tribe found that in Lake Sammamish, smallmouth bass preferentially locate their nests near residential piers and associated in-water structures (Kahler et al. 2001). These findings are consistent with the findings of Stein (1970), who observed a largemouth bass affinity for dock, piers, and associated pilings.

Interactions of smallmouth bass and juvenile salmonids depend on factors such as timing of salmonid outmigration, salmonid species, and residence of the juvenile salmonids in lentic or lotic environments (Warner 1972; Pflug and Pauley 1984; Gray et al. 1984; Gray and Rondorf 1986; Poe et al. 1991; Shively et al. 1991; Tabor et al. 1993 and 2000; Fayram and Sibley 2000). Although substrate type often determines the acceptability of an area for bass spawning, adjacent cover and structural complexity are also necessary for protection while the fish are concentrated in shallow water (Stein 1970; Cooper and Crowder 1979; Helfman 1981; Pflug and Pauley 1984). Therefore, one would expect that an increase in numbers of docks, piers, boathouses, and floats could be beneficial to the bass population by increasing spawning habitat utilization. Increases in the concentration of bass in spawning sites where juvenile salmonids are present may increase the predation on juvenile salmonids. However, researchers have indicated that structural complexity can moderate predator–prey interactions by providing more refuges for prey species as well as reducing the foraging efficiency of the predator (Cooper and Crowder 1979). This moderation may apply to naturally occurring structural habitat complexity, as well as habitat complexity due to the presence of docks, piers, boathouses, and associated pilings. In such a case, fish may adapt to the use of artificial structures in lieu of natural habitats.

Prey such as juvenile salmonids, in the absence of natural hiding cover, may use artificial structures as refuge. However, snorkel observations conducted by Roger Tabor in Lake Washington indicate that although they may migrate along the shoreline, passing under docks, the juvenile Chinook salmon prefer open areas rather than areas covered by docks (King County 2000). Moreover, although manmade structures can serve as refuge for prey, they may also provide refuge for predators (Cooper and Crowder 1979).

It has been suggested that the increase in the number of docks around the shoreline of Lake Washington might have caused the observed decrease in freshwater survival of juvenile sockeye salmon (Fayram 1996). Studying the spatial location and temporal duration of predation by bass on juvenile sockeye salmon, Fayram (1996) speculated that the increase in docks potentially provided increased locations for bass to ambush prey such as juvenile sockeye salmon while they are in the littoral zone. Fayram (1996) also suggested that the cumulative effect of an increase in predation due to the increase in number of docks may have been great enough to cause the decline in sockeye salmon freshwater survival.

The presence of docks and piers may adversely affect existing aquatic vegetation, potentially altering predator–prey interactions, particularly those in which largemouth bass play a role. In Lake Baldwin, Florida, largemouth bass showed a significant preference for piers only where aquatic vegetation was absent (Colle et al. 1989). In Lake Sammamish, largemouth bass have been shown to prefer moderate to dense vegetation and silt and sand substrate (Pflug 1981). The preference of largemouth bass for aquatic vegetation habitat may increase their foraging success on passing schools of salmonids, compared with the lesser success of smallmouth bass that occupy habitat with little concealment (Pflug 1981; Helfman 1981b). Consistent with these findings, Fayram (1996) found that in Lake Washington, largemouth bass are more structurally oriented than smallmouth bass.

Beamesderfer and Rieman (1988) studied juvenile salmonid predation by northern pikeminnow and smallmouth bass in a mainstem Columbia River reservoir. Beamesderfer and Rieman (1988) concluded that northern pikeminnow have the greatest potential for predation of juvenile salmonids because of their preference for in-shore low-velocity microhabitat. Low-velocity microhabitat can be created by in-water structures such as jetty pilings (Petersen et al. 1993), but can also be created by dock and pier pilings located along the banks of narrow, fast-flowing sections of the Columbia River reservoirs (Carrasquero 2000 unpublished observation). Therefore, one would expect that resulting low-velocity microhabitats could potentially increase juvenile salmonid predation by providing aggregating habitat for northern pikeminnow and perhaps juvenile salmonids as well.

Additional evidence of predation by pikeminnow was found by Petersen et al. (1993), who, in a study of the system-wide significance of predation on juvenile salmonids in Columbia and Snake river reservoirs, found that northern pikeminnow feed primarily on juvenile salmonids. The authors speculated that northern pikeminnow as well as juvenile salmonids might congregate near flow shears (i.e., back-eddies) created by in-water structures (i.e., jetty pilings), to avoid high-velocity water (Petersen et al. 1993). This preference of northern pikeminnow for back-eddies has been reported elsewhere (Faler et al. 1988). Consequently, in the Columbia and Snake river reservoirs, in-river obstructions associated with over-water structures such as jetty pilings can make salmonids more vulnerable to predation.

The Washington Department of Fish and Wildlife has developed a number of recommendations for regulating shoreline structures:

- To provide maximum protection to juvenile Chinook salmon, development should be restricted in existing undeveloped shorezone areas, particularly in those areas having the characteristics preferred by this species (i.e., low-gradient habitats with sandy bottom and no aquatic vegetation).

- To minimize the cumulative effects of over-water structures, in particular the loss of habitat and the potential creation of refuge for predators, all structures should be as narrow as possible to achieve the project purpose.
- The number and body size of organisms using an area influenced by a floating object are directly related to the surface area of the object. Therefore, if a new over-water structure is to be allowed, the minimum possible size should be used to minimize the attraction of salmonid predators such as bass.
- Smallmouth bass and largemouth bass have a strong affinity to pilings. Therefore, for all new projects, and for retrofitting projects when feasible from an engineering perspective, a downgrade in size and number of pilings should be required in order to minimize potential predation on juvenile salmonids.
- Pier and dock pilings, which intercept gravel transport, may accelerate beach erosion. Therefore, the use of buoy and anchor systems should be preferred over pilings to prevent beach erosion.
- In order to minimize the potential for predation on juvenile salmonids in free-flowing areas of systems where northern pikeminnow occur, the placement of in-water structures that create back-eddies and low-velocity microhabitat should not be allowed.
- New bulkheads should not be permitted under any circumstance; instead, bioengineering solutions should be required. For retrofitting projects, bulkheads should be completely eliminated when possible or relocated shoreward of ordinary high water, and shorelines should be restored with emergent and riparian plant species.
- Riprap should not be allowed as an erosion control measure. Instead, site specific bioengineering techniques should be required when alteration of the natural shoreline conditions is unavoidable, or for retrofitting projects.
- Given that shading can affect habitat function by creating visual barriers to migrating fish, new and retrofitted overwater structures should be required to incorporate design elements to minimize the shaded area under the structure.
- Because leachate from treated wood is toxic to aquatic organisms, the use of treated wood should not be allowed in construction of over-water structures.

Similar provisions have been adopted in the Shoreline Management Guidelines in Chapter 173-16 of the Washington Administrative Code that apply to “shorelines of the state (generally streams with flow of greater than 20 csf). Criteria include:

- New development should be located and designed to avoid the need for future shoreline stabilization to the extent feasible. Subdivision of land must that the lots created will not require shoreline stabilization in order for reasonable development to occur;
- New structural stabilization measures shall not be allowed except when necessary to protect existing primary structures when the structure is in danger from shoreline erosion excluding normal sloughing, erosion of steep bluffs, or shoreline erosion and nonstructural measures, such as placing the development further from the shoreline, planting vegetation, or installing on-site drainage improvements, are not feasible or not sufficient.
- When structural shoreline stabilization measures are demonstrated to be necessary, they should be limited to the minimum necessary and soft approaches shall be used unless demonstrated not to be sufficient. WAC 173-26-231(3)

2.4 HABITAT MANAGEMENT AND PROTECTION TOOLS

2.4.1 Designation, Rating, and Classification

There is no universally accepted method for classifying rivers, streams and lakes for regulatory purposes. In the State of Washington, there are a variety of classification systems used by different agencies based on specific regulatory needs. For example, the Department of Ecology classifies water types for the purposes of meeting water quality standards and employs a system that emphasizes the use of the water and the requirements of the Federal Clean Water Act while the Department of Natural Resources (DNR) utilizes a system based on forest practices needs.

Growth Management Hearings Board decisions clearly indicate that use of the DNR classification system, or any other particular system, is not required as long as a classification system meets the protection requirement of the Act. Lewis County currently utilizes the "interim" DNR system which employs five categories of waters:

"Type 1 Water" means all waters, within their ordinary high-water mark, as inventoried as "shorelines of the state" under chapter 90.58 RCW and the rules promulgated pursuant to chapter 90.58 RCW, but not including those waters' associated wetlands as defined in chapter 90.58 RCW.

"Type 2 Water" means segments of natural waters which are not classified as Type 1 Water and have a high fish, wildlife, or human use. These are segments of natural waters and periodically inundated areas of their associated wetlands, which:

(a) Are diverted for domestic use by more than 100 residential or camping units or by a public accommodation facility licensed to serve more than 10 persons, where such diversion is determined by the department to be a valid appropriation of water and only considered Type 2 Water upstream from the point of such diversion for 1,500 feet or until the drainage area is reduced by 50 percent, whichever is less;

(b) Are diverted for use by federal, state, tribal or private fish hatcheries. Such waters shall be considered Type 2 Water upstream from the point of diversion for 1,500 feet, including tributaries if highly significant for protection of downstream water quality. The department may allow additional harvest beyond the requirements of Type 2 Water designation provided by the department of fish and wildlife, department of ecology, the affected tribes and interested parties that:

(i) The management practices proposed by the landowner will adequately protect water quality for the fish hatchery; and

(ii) Such additional harvest meets the requirements of the water type designation that would apply in the absence of the hatchery;

(c) Are within a federal, state, local or private campground having more than 30 camping units: Provided, that the water shall not be considered to enter a campground until it reaches the boundary of the park lands available for public use and comes within 100 feet of a camping unit.

(d) Are used by fish for spawning, rearing or migration. Waters having the following characteristics are presumed to have highly significant fish populations:

(i) Stream segments having a defined channel 20 feet or greater within the bankfull width and having a gradient of less than 4 percent.

(ii) Lakes, ponds, or impoundments having a surface area of 1 acre or greater at seasonal low water; or

(e) Are used by fish for off-channel habitat. These areas are critical to the maintenance of optimum survival of fish. This habitat shall be identified based on the following criteria:

(i) The site must be connected to a fish bearing stream and be accessible during some period of the year; and

(ii) The off-channel water must be accessible to fish through a drainage with less than a 5 percent gradient.

"Type 3 Water" means segments of natural waters which are not classified as Type 1 or 2 Waters and have a moderate to slight fish, wildlife, or human use. These are segments of natural waters and periodically inundated areas of their associated wetlands which:

(a) Are diverted for domestic use by more than 10 residential or camping units or by a public accommodation facility licensed to serve more than 10 persons, where such diversion is determined by the department to be a valid appropriation of water and the only practical water source for such users. Such waters shall be considered to be Type 3 Water upstream from the point of such diversion for 1,500 feet or until the drainage area is reduced by 50 percent, whichever is less;

(b) Are used by fish for spawning, rearing or migration. The requirements for determining fish use are described in the board manual section 13. If fish use has not been determined:

(i) Waters having any of the following characteristics are presumed to have fish use:

(A) Stream segments having a defined channel of 2 feet or greater within the bankfull width in Western Washington; or 3 feet or greater in width in Eastern Washington; and having a gradient of 16 percent or less;

(B) Stream segments having a defined channel of 2 feet or greater within the bankfull width in Western Washington; or 3 feet or greater within the bankfull width in Eastern Washington, and having a gradient greater than 16 percent and less than or equal to 20 percent, and having greater than 50 acres in contributing basin size in Western Washington or greater than 175 acres contributing basin size in Eastern Washington, based on hydrographic boundaries;

(C) Ponds or impoundments having a surface area of less than 1 acre at seasonal low water and having an outlet to a fish stream;

(D) Ponds of impoundments having a surface area greater than 0.5 acre at seasonal low water.

(ii) The department shall waive or modify the characteristics in (i) of this subsection where:

(A) Waters have confirmed, long term, naturally occurring water quality parameters incapable of supporting fish;

(B) Snowmelt streams have short flow cycles that do not support successful life history phases of fish. These streams typically have no flow in the winter months and discontinue flow by June 1; or

(C) Sufficient information about a geomorphic region is available to support a departure from the characteristics in (i) of this subsection, as determined in consultation with the department of fish and wildlife, department of ecology, affected tribes and interested parties.

"Type 4 Water" means all segments of natural waters within the bankfull width of defined channels that are perennial nonfish habitat streams. Perennial streams are waters that do not go dry any time of a year of normal rainfall. However, for the purpose of water typing, Type 4 Waters include the intermittent dry portions of the perennial channel below the uppermost point of perennial flow. If the uppermost point of perennial flow cannot be identified with simple, nontechnical observations (see board manual, section 23), then Type 4 Waters begin at a point along the channel where the contributing basin area is:

(a) At least 13 acres in the Western Washington coastal zone (which corresponds to the Sitka spruce zone defined in Franklin and Dyrness, 1973);

(b) At least 52 acres in other locations in Western Washington;

(c) At least 300 acres in Eastern Washington.

"Type 5 Waters" means all segments of natural waters within the bankfull width of the defined channels that are not Type 1, 2, 3, or 4 Waters. These are seasonal, nonfish habitat streams in which surface flow is not present for at least some portion of the year and are not located downstream from any stream reach that is a Type 4 Water. Type 5 Waters must be physically connected by an above-ground channel system to Type 1, 2, 3, or 4 Waters.

New water types have been established by DNR in WAC 222-16-030, but this system will not go into effect until fish habitat water type maps have been adopted by the State. Until such time, the interim water typing system established in WAC 222-16-031 will continue to be used by the State. New water types are presented below for informational purposes along with a conversion table for the interim and new water types.

As excerpted from WAC 222-16-030, new water types are as follows:

- **Type S Water** - all waters, within their bankfull width, as inventoried as "shorelines of the state" under chapter 90.58 RCW and the rules promulgated pursuant to chapter 90.58 RCW including periodically inundated areas of their associated wetlands.
- **Type F Water** - segments of natural waters other than Type S Waters, which are within the bankfull widths of defined channels and periodically inundated areas of their associated wetlands, or within lakes, ponds, or impoundments having a surface area of 0.5 acre or greater at seasonal low water and which in any case contain fish habitat.
- **Type Np Water** - means all segments of natural waters within the bankfull width of defined channels that are perennial nonfish habitat streams. Perennial streams are waters that do not go dry any time of a year of normal rainfall. However, for the purpose of water typing, Type Np Waters include the intermittent dry portions of the perennial channel below the uppermost point of perennial flow.
- **Type Ns Water** - means all segments of natural waters within the bankfull width of the defined channels that are not Type S, F, or Np Waters. These are seasonal, nonfish habitat streams in which surface flow is not present for at least some portion of a year of normal rainfall and are not located downstream from any stream reach that is a Type Np Water. Ns Waters must be physically connected by an above-ground channel system to Type S, F, or Np Waters.

Conversion between the water types is presented in WAC 222-16-031 as follows:

Permanent Water Typing	Interim Water Typing
Type S	Type 1
Type F	Types 2 and 3
Type Np	Type 4
Type Ns	Type 5

The DNR classification system has several peculiarities due to its use in regulating forest practices. The most singular is the single classification for all shorelines under the State Shoreline Management Act jurisdiction. These include streams with a flow of 20 cfs up to rivers with large flows such as the mainstems of the Cowlitz and Chehalis Rivers. For DNR use, this classification is useful because they are required to apply certain management restrictions to shoreline, particularly “Shorelines of Statewide Significance.”

2.4.2 Buffers

For protection of instream salmonid habitat conditions, a wide range of recommended riparian buffer widths is presented in existing studies (see previous discussion of riparian buffer functions). As used in this section, buffers differ from “riparian areas” or “riparian corridors”; buffers are a regulatory mechanism that incorporates some of the functions provided by riparian areas. Variations in recommendations for buffers are based on the functions that are desired to be provided and the effectiveness at which they can be provided in a specific area. This is also affected by variation in site conditions such as side-slope angle, stream type, geology and climate, and other factors. Design of riparian buffers must consider the ecological, cultural, and economic values of the resource, land use characteristics, and existing riparian quality throughout watersheds in order to address the cumulative impacts on stream functions and the resources being protected (Johnson and Ryba 1992; Castelle et al. 1994; Wenger 1999).

Buffers as used in this report function to some extent to separate incompatible uses from the habitat areas as provided in WAC 365-190-080(5)(b)(v) but also function as an integral part of the resource. Appropriate buffer sizes necessary to maintain the desired riparian or stream functions may be affected by adjacent land use or activities. A wider buffer may be desired to protect streams from impacts resulting from impervious surfaces on adjacent land and associated runoff and from activities such as recreation use, ad hoc trails, predation from pets, tree removal for view improvements and hazard reduction, and proximity impacts such as noise or artificial lighting. These concerns are associated more with areas of high-intensity land use. In such areas, wider buffers or restrictions (such as building setbacks) that keep a potential hazard from occurring, may be needed, while narrower buffers may suffice in areas of low-intensity land use (May 2000). It should be noted though that opportunities for protection or improvement of buffer conditions in areas of high-intensity land use are often effectively foreclosed by existing development, or the existing habitat conditions are already highly altered. Under such conditions, establishing buffers wide enough to provide an effective full range of riparian functions is likely unattainable, and other actions may be required to improve habitat conditions beyond what riparian buffers are able to provide. In addition, buffer vegetation type, diversity, condition, and maturity are equally as important as buffer width, and the best approach to providing high-quality buffers is to strive for establishing and maintaining mature native vegetation communities (May 2000).

Pollack and Kennard (1998) recommended buffer widths of 250 feet on all perennial streams. Buffer widths of one SPTH would reasonably provide for a full range of riparian functions, and therefore, not contribute significantly to the loss of salmonid habitat. May (2000) and other extensive reviews provide detailed summaries of buffer width sizes necessary to achieve stream and riparian functions (Knutson and Naef 1997; FEMAT 1993). The conclusions of those reviews are presented in Tables 2-2, 2-3, and 2-4. However, as was previously discussed, these recommended buffer widths are largely driven by providing adequate long-term LWD recruitment potential, and are not necessarily representative of all situations. For example, along intensively managed streams such as in agricultural, residential, or commercial areas, some functions normally provided (at least in part) by riparian buffers, such as flow attenuation or filtration of pollutants, can be provided by application of appropriate BMPs in combination with smaller buffers.

In addition, the importance of protecting the CMZ is well documented. Many researchers recommend that buffer widths be measured from the edge of the CMZ on streams with active channel migration zones (Knutson and Naef 1997; May 2000; WDNR 1999; Smith 2002). Incorporating CMZs into County regulations should be provided for, but using CMZs as the basis for buffer determination poses some challenges in a regulatory context because the extent of the CMZ will vary from parcel to parcel and has not been determined for most streams and rivers in Lewis County.

Lewis County buffer designations for rivers and streams are currently tiered to current or proposed State water typing classifications. Standard buffer width requirements for streams regulated under the CAO distinguish between urban and rural characteristics, and high- and low-intensity uses. For purposes of the buffer requirements, urban streams are classified as those portions of streams which are contained within a County-designated Urban Growth Area (UGA), while rural streams are classified as those portions of streams which lie outside a County-designated UGA.

Low-intensity uses are defined as uses, which by their nature generally have a low or moderate impact on the environment in which they occur and will be regulated using a single or short form of approval (LCC 17.35.240). Low-intensity uses include the following:

(1) Agricultural uses, except those uses involving:

(a) Livestock in excess of grazing best management practices recommended by the Natural Resources Conservation Service;

(b) Machinery storage, fueling, and maintenance; or

(c) Storage of petroleum, fertilizers, pesticides, and herbicides.

(2) Residential uses with less than 35 percent impervious surface of the parcel.

(3) Commercial uses with less than 50 percent impervious surface, less than 5,000-square-foot buildings, and all storm water treated through storm drains consistent with County standards.

(4) Any use similar in size, scale, and impact to uses (1) to (3) where the rate of the storm water discharged from the site is less than 110 percent of the rate storm water discharged in a predevelopment state, and all storm water discharged to the wetland has been treated through storm drains consistent with County standards.

It should be noted that this definition of low intensity use is not specifically related to the impacts produced to the aquatic system and should be re-evaluated according to thresholds at which specific effects are likely.

All uses that do not conform to the definition of low-intensity are classified as high-intensity uses. Table 2-7 lists the required buffer widths under the existing code.

Table 2-7. Existing Lewis County CAO Stream Buffers

Stream Type	Buffer Type			
	Rural Stream Buffers (feet)		Urban Stream Buffers (feet)	
	High Intensity Uses	Low Intensity Uses	High Intensity Uses	Low Intensity Uses
Type 1	100	50	100	50
Type 2	100	50	75	50
Type 3	100	50	50	50
Type 4	50	25	25	25
Type 5*	25	25	10	10

*Natural watercourse only.

Also, according to the exiting code, the stream buffer is measured horizontally in a landward direction from the ordinary high water mark. Where lands adjacent to a stream display a continuous slope of 50 percent or greater, the buffer includes such sloping areas. For Type 1, 2, and 3 streams, where the horizontal distance of the sloping area is greater than the required standard buffer, the buffer extends to a point 25 feet beyond the top of the bank of the sloping area.

Alterations to stream buffers are currently allowed in the following cases:

(a) **Averaging Buffer Widths** - The width of a buffer may be averaged, thereby reducing the width of a portion of the buffer and increasing the width of another portion, if all of the following requirements are met:

(i) Averaging will not impair or reduce the habitat, water quality purification and enhancement, storm water detention, ground water recharge, shoreline protection, erosion protection, and other functions of the stream and buffer;

(ii) The total area of the buffer on the subject property is not less than the buffer which would be required if averaging was not allowed;

(iii) No part of the width of the buffer is less than 50 percent of the required width or 25 feet, whichever is greater.

(b) **Reducing Buffer Widths** - Buffer widths may be reduced if the buffer is enhanced in accordance with the following requirements:

(i) Buffers, or buffers reduced after buffer averaging, will have a minimal function or value based on existing physical characteristics;

(ii) The applicant demonstrates that the proposed buffer enhancement, together with proposed buffer width reduction, will result in an increase in the functions and values of the buffer when compared with the functions and values of the standard buffer;

(iii) The applicant includes a comparative analysis of buffer values prior to and after enhancement, and demonstrates compliance with this section;

(iv) The buffer width is not reduced below 50 percent of the standard buffer width or 25 feet, whichever is greater, and the total buffer area reduction is not less than 75 percent of the total buffer area before reduction;

(v) The functions and values of the stream protected by the buffer are not decreased.

These criteria provide flexibility but present challenges in implementation in cases where specific functional relationships are not well defined.

Buffers on lakes provide many of the functions provided on riparian systems discussed above. The functions related to depth of buffer are similar to the results noted for streams.

Large woody debris is an important habitat component of lake upland and aquatic (littoral) areas. LWD recruitment for lakes depends on the same physical mechanisms as discussed for streams.

An overall conclusion from the review of the applicable buffer literature is that the buffer width required to protect a given shoreline habitat function or group of functions depends on various site-specific factors. This includes plant community (species, density, age); slope; amount of natural organic matter covering the soil; and soil type. In general, literature on lake buffers indicates that the appropriate buffer width is site- and function-specific, and a 50-foot-wide buffer appears to be adequate to provide water quality functions and recruitment of leaf litter and large woody debris.

2.4.3 Preservation of Shoreline Structure

In order to avoid habitat alterations and stop the loss of shoreline areas and functions, bulkheads needing any type of maintenance, repair, and/or retrofitting should be considered for removal or replacement with vegetative and LWD structures as shoreline protection alternatives. This recommendation is based on a conservative interpretation of the best available science. If a complete removal is not feasible, the bulkheads should be relocated landward of the OHWM, and the shoreline should be restored with emergent and riparian plant species. The latter would represent a less conservative interpretation of what is indicated by the best available science to stop the loss of shoreline areas and functions.

There are instances where both a bulkhead and fill currently occur below the official OHWM elevation, and where the geomorphic configuration of the shoreline has been straightened, thereby eliminating natural convolution. In those instances, and in order to restore the natural shoreline configuration, it is recommended that the bulkhead replacement be accompanied with a geomorphic reconfiguration of the shoreline.

Where bulkheads are removed, shoreline erosion prevention could be addressed through the implementation of bioengineering vegetation measures such as marsh creation. Plant marshes perform two functions in controlling shore erosion: dissipation of energy and stabilization of shoreline sediments. Energy dissipation is achieved through the exposed stems of plants (e.g., emergent vegetation), which form flexible masses that dissipate energy.

Shoreline stability is obtained by root cohesion provided by the marsh shrub and trees layers of vegetation. Additional shoreline stability is achieved through dense stands of marsh vegetation, which create depositional areas that cause sediment accretion along the shoreline (USEPA 1993). Created marsh areas could be counted towards the required buffer width when located in areas of previous fill. Additional bioengineering techniques that should also be implemented include heavy planting of cedar trees and willows and other riparian shrubs in conjunction with structural LWD inclusions along the shoreline edge.

In addition, engineered prototype bulkheads that include bioengineering vegetation measures and structural woody components could be implemented along lake shorelines in Lewis County, in places where bulkheads currently occur below the official OHWM and a complete removal is not feasible. The prototype bulkheads should always be relocated landward of the OHWM and may be performed concurrently with beach nourishment activities (matching historical substrate). These restoration actions should focus on evaluating potential solutions for reducing upper beach loss along armored shorelines by increasing the elevation at which bulkheads are built and roughening the structures to dissipate wave and boat wake energy and to trap sediment.

A monitoring plan should be implemented to evaluate the success of areas stabilized through the use of bioengineering techniques. For this purpose, quantifiable criteria included in the performance standards should be used as the basis for monitoring success. The monitoring plan should be implemented together with demonstration (pilot) projects to test the effectiveness of various bioengineering techniques.

A no-wake zone should be imposed along all shorelines on a zone extending from the OHWM to 300 feet offshore in lakes that receive motorized boat use, to minimize wake erosion effects on the shoreline. A boat speed limit should be imposed on smaller lakes.

2.4.4 Timing restrictions

Timing restrictions for conducting in-water work are necessary to protect habitat and life-stage requirements that differ by species and time of year. No timing restrictions for in-water work are specified in the LCC, but windows for conducting work within the OHWM of freshwater systems have been established by state and federal resources agencies. The general approved fish work windows for most Lewis County streams is from July 1 to September 30, although in some cases the fish work window is much shorter (August 1 to August 31 in the Cowlitz River and August 1 to August 15 in the Cispus River).

2.4.5 Impervious Surface and Stormwater Management Options

Stormwater is the water that runs off surfaces such as rooftops, paved streets, highways, and parking lots. It can also come from hard grassy surfaces like lawns or play fields and from graveled roads and parking lots which studies have shown that they can be virtually impervious.

Urban development causes significant changes in patterns of stormwater flow from land into receiving waters. Water quality can be harmed when runoff carries contaminants such as oil, metals, or pesticides into streams, wetlands, lakes, and marine waters or into groundwater. Better managing stormwater runoff helps to reduce this significant pollution problem that makes waterways unhealthy for people and fish.

The majority of Lewis County is at rural densities that do not require stormwater management facilities. However there are a number of cases where development is of a density where stormwater management is needed, including:

- Existing rural communities;
- Urban Growth Areas;
- Higher intensity uses allowed by special permit;
- Fully Contained Communities
- Master Planned Resorts
- Major industrial developments

There are two components of stormwater management generally required:

- **Flow Management**
- **Water Quality**

Flow Management refers to the restriction of the discharge of stormwater to rates based on the discharge that would be expected from storms of a given frequency and duration. Detention facilities are required to store stormwater so that it can be more slowly metered to meet flow management standards.

As a consequence of the urban-induced runoff changes that cause flooding, erosion, and habitat damage, jurisdictions have long required some degree of stormwater mitigation for new developments. The most common approach has been to reduce flows through the use of detention ponds, which are intended to capture and detain stormwater runoff from developed areas. This can be designed to either of two levels of performance, depending on the desired balance between achieving downstream protection and the cost of providing that protection.

- A "***peak" standard*** seeks to maintain postdevelopment peak discharges at their predevelopment levels. This is the type of standard currently used by Lewis County.

- A ***"duration" standard:*** seeks to maintain the postdevelopment *duration* of a wide range of peak discharges at predevelopment levels. This is a presumed threshold discharge below which there are "no effects" of flow-duration increase.

The ***peak standard*** used by Lewis County seeks to maintain postdevelopment peak discharges at their predevelopment levels. Even if this goal is successfully achieved the aggregate duration that such flows occupy the channel must increase because the overall volume of runoff is greater.

Several problems with this methodology have been identified. Ponds are assumed to be empty at the beginning of a storm; however, this is rarely the case during (commonly sequential) wet-season storms. In addition Soil Conservation Service (SCS) curve number hydrology also commonly overestimates pre-development flows which set an inaccurate target. This tendency is sometimes exacerbated by design engineers who adjust the time of concentration and curve number to reduce the size of the detention on their client's behalf. Furthermore, the SCS methodology is a "peak standard" that does not account for problems associated with increased flow durations. Continuous flow modeling revealed that the ponds designed with the SCS method would not achieve the protection of stream functions (Booth, 1997).

In contrast, a ***duration standard*** seeks to maintain the postdevelopment *duration* of a wide range of peak discharges at predevelopment levels. The total *volume* of runoff must still increase in the postdevelopment condition; thus durations cannot be matched for all discharges because this "excess" water must also be released.

Duration standards seek to avoid potential disruption to the downstream channels by choosing a "threshold discharge," below which sediment transport in the receiving channel is presumed not to occur and so postdevelopment flow durations can be increased without concern. This choice can be made by site-specific, but rather expensive, analysis based on stream hydraulics and sediment size or can be applied as a "generic" standard based on predevelopment discharges.

A common approach is to require stormwater systems to meet a duration standard similar to the flow standards in the 2005 Ecology Stormwater Manual for Western Washington. Flow control is designed to control the durations of geomorphically significant flows and thereby maintain existing channel and streambank erosion rates. A geomorphically significant flow is one which moves channel bedload sediments. The flow that initiates transport of channel sediments varies from channel to channel, and can be determined using the model in the 2005 manual.

Several issues remain with duration control standards:

- ***"Threshold" discharge:*** It is difficult to define a threshold discharge below which there are "no effects" of flow-duration increase.

- ***Point discharge:*** The consequences of converting a natural condition of dispersed overland flow into numerous headwaters into a point discharge at a surface-water outfall can result in locally severe erosion and disruption of riparian vegetation and instream habitat (*e.g.*, Booth, 1990).

- ***Groundwater: F***low durations control will not address changes to groundwater recharge or discharge, because no constructed detention ponds, even the largest designed under this standard, can delay wintertime rainfall sufficiently for it to become summertime runoff.

- ***Individual storm hydrographs:*** There is no attempt (or ability) to construct detention ponds that match durations for specific storm events or even an entire storm season. Thus the *aggregate* flow-duration spectrum may be unchanged, but the timing and brevity of any single storm hydrograph may be quite different from the undisturbed condition.(Booth 1997).

Water Quality measures currently in effect in Lewis County are based on case-by case analysis. The 2005 stormwater manual provides a more extensive menu of source control and runoff treatment measures and guidance for applicability that will generally result in a higher assurance of providing water quality that will minimize effects on aquatic resources.

A variety of methods are available to reduce the amount and/or the effect impervious surfaces as part of site design or facility design and materials. These approaches are often characterized as low impact development. A wide variety of strategies are available including:

- Cluster homes to:
  - Reduce overall development envelope/preserve native vegetation and soils (minimize disturbance)
  - Reduce road length
  - Eliminate or reduce stream crossings or other critical areas impacts
  - Use site planning to protect native vegetation and soils (minimize disturbance)
- Road and driveway area reduction:
  - Reduce road widths and turn around areas in residential developments, construct parking on one side of the street, use permeable pavers in non-drive lanes
  - Narrow lot frontages to reduce overall road length per home (Schueler 1995)
  - Reduce front yard set-backs to reduce driveway length
- Provide trail system to connect services and reduce use of vehicles and reduce pollutant load)
- Prescribe minimum standards for:
  - Retention of native vegetation open space areas
  - Maximum impervious surfaces
- Increasing infiltration through
  - ➢ Permeable Pavers such as Ecostone and Gravelpave; Permeable Asphalt; and Permeable Concrete. These are generally recommended for road shoulders, parking lanes, driveways, parking lots, and turn-arounds.
  - ➢ Increase potential for infiltration through amended soils with compost or stockpiled native materials in lawns, parks, and greenbelts.

- Downspout/Roof drain dispersion into native vegetation in both residential and commercial developments
- Raingardens/storage tanks for use in both residential and commercial developments

In some cases, existing codes and standards, such as road width standards do not provide for some of the elements listed above. In general, to achieve standards and practices that reduce the amount or effects of runoff from impervious surfaces requires flexible standards and performance measures to determine the adequate level of low impact features to be incorporated in a project. A variety of methods are available to reduce the amount and/or the effect impervious surfaces as part of site design or facility design and materials. These approaches are often characterized as low impact development. A wide variety of strategies are available including:

- Developing approaches to match the development to the natural landscape to minimize land disturbance including maintaining drainage patterns and restricting development and disturbance in valuable hydrologic areas such as woods or other established native vegetation and highly permeable soils, and avoiding change in land cover runoff characteristics.
- Reducing the area of impervious surfaces such as roofs, roads and sidewalks through clustering buildings and other developed areas based on specific hydrologic objectives.
- Determining appropriate facilities and materials, including facilities that will complement critical areas and their buffers.

Mechanisms that can be incorporated in codes and standards may include:

- Maximum impervious surface standards applied to lots or developed areas;
- Standards for reduced width of streets, consistent with function and emergency access requirements;
- Incorporation of parking or other impervious surface in buildings through provisions allowing modification of bulk standards such as maximum height
- Standards for incorporating measure to encourage infiltration rather than surface water runoff.

2.5 PROTECTION AND MANAGEMENT OF ANADROMOUS SPECIES

Habitat used by anadromous fish is potentially found in all types of FWHCAs listed in LCC 17.35. The LCC does not provide specific guidelines for protecting anadromous salmonid species, but the protection and management of anadromous salmonids is addressed in regulations potentially applicable to aquatic habitats.

The protection and recovery of anadromous salmonids species is a primary focus in Lewis County. The County, resource agencies, tribes, and private interests have coordinated protection and management efforts for anadromous species in Lewis County. Existing habitat conditions, habitat limiting factors, and proposed protection measures for anadromous salmonids in Lewis County have been presented in several completed or ongoing management documents (LCFRB 2002; WSCC 2000, 2001). These documents have been developed with the intent of identifying specific habitat issues throughout the Cowlitz and Chehalis river watersheds and other waters of Lewis County, and proposing protections and strategies for conserving anadromous salmonid populations. Protection measures and goals that have been identified within the Lewis County include:

- Protect and enhance riparian functions and improve riparian conditions throughout Lewis Country watersheds through restoration of the natural riparian plant community, exclusion of livestock from riparian areas, and eradication of invasive plant species from riparian areas.
- Manage forest practices, agricultural practices, and growth and development to minimize impacts to sediment supply processes, runoff regime, and water quality.
- Set back, breach, or remove artificial confinement structures. Reduce bank hardening and investigate areas for dike removal and reconnection of the floodplain. High impact areas include the mainstem Cowlitz River below Mayfield Lake, the mainstem Chehalis River in the Centralia/Chehalis and other areas dominated by agricultural, residential, and municipal land-uses.
- Restore degraded water quality with emphasis on temperature impairments by increasing riparian shading in tributaries and decreasing channel width-to-depth ratios.
- Restore degraded hillslope processes on forest, agricultural, and developed lands by upgrading or removing problem forest roads; reforesting heavily cut areas not recovering naturally; employing agricultural BMPs with respect to contaminant use, erosion, and runoff; reducing watershed imperviousness; and reducing effective stormwater runoff from developed areas.
- Restore or create off-channel and side-channel habitats where they have been eliminated, particularly on the lower and middle mainstems of the Cowlitz and Chehalis Rivers.
- Restore access to isolated habitats blocked by culverts, dams, or other barriers focusing on those cases with good potential benefit and reasonable project costs.
- Restore channel structure and stability by placing stable woody debris in streams to enhance cover, pool formation, bank stability, and sediment sorting; modifying channel morphology to create suitable habitat; and restoring natural rates of erosion and mass wasting within river corridors.
- Provide for adequate instream flows during critical periods through managing water withdrawals (water rights closures and enforcement), hydro regulation, acquisition of existing water rights, and implementation of water conservation.

Notwithstanding these efforts, there is a need to strengthen existing regulations at the County level to achieve the goal of no net loss of ecological functions as specified under the GMA. Specific recommendations are provided in Section 3.

3. GMA REQUIREMENTS AND REGULATORY OPTIONS

3.1 GMA REQUIREMENTS

The basic requirements for the protection of critical areas are found in the following statutes and guidelines:

- The GMA requires designation and protection of Critical Areas (RCW 36.70A.170).
- In designating and protecting critical areas under this chapter, counties and cities shall include the best available science in developing policies and development regulations to protect the functions and values of critical areas. (RCW 36.70A.172(1)) Criteria for determining best available science are contained in the Washington Administrative Code (WAC) 365-195-900 through 925
- In addition, counties and cities shall give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries. (RCW 36.70A.172(1)).

There are several Growth Management Hearings Board and court cases that have provided clarification of what is meant by *protection* of critical areas. One of the most important cases defined protection as:

> The Act's requirement to protect critical areas, particularly wetlands and fish and wildlife habitat conservation areas means that the values and functions of such ecosystems must be maintained. While local governments have the discretion to adopt development regulations that may result in localized impacts upon, or even the loss of, some critical areas, such flexibility must be wielded sparingly and carefully for good cause, and in no case result in a net loss of the value and functions of such ecosystems within a watershed or other functional catchment area. (*Tulalip Tribes of Washington (Tulalip I) v. Snohomish County,* CPSGMHB Case No. 96-3-0029).

A number of other hearings board or court cases address specific aspects of protection and are discussed under in subsequent subsections.

Lewis County has adopted a number of relevant policies in the Comprehensive Plan relating to aquatic species:

> **Policy LU 1.4** Allowance should be made for greenbelt and open space areas, fish and wildlife habitat, migration routes and other environmentally sensitive areas when determining land requirements for urban growth areas.
>
> **Policy NR 1.6** The County endorses the concept of cooperative resource management as developed in the Washington State Timber, Fish, and Wildlife agreement, which is an agreement among industrial timber landowners, environmental groups, state resource agencies, Indian tribes, and counties for managing the state's public and private timberlands and public resources.
>
> **Policy NE 4.3** Encourage the preservation of wetlands, open lands, and habitat areas for the benefit of the County's indigenous fish and wildlife and quality of life of county residents.
>
> **Policy NE 4.4** Promote responsible, multiple uses of the land that minimize impacts to outdoor recreation, fish and wildlife habitats, and watersheds.

3.2 INVENTORY AND CLASSIFICATION OPTIONS

The overall intent of the pertinent sections of the GMA and WAC 365-190-020 is to assure no further degradation, negative impacts, or additional loss of functions or values of critical areas. The regulations focus on new activities and preventing new impacts or new degradation rather than requiring enhancement of existing conditions (*Swinomish Indian Tribal Community et al. v. Skagit County; 02-2-0012c*).

The designation of a critical area should include a classification scheme and general location determination or performance standards for specific locations (*CCNRC v. Clark County 96-2-0017*). Classification systems should ideally be biologically and physically relevant to the fisheries resource, while also providing for ease of public understanding and straightforward County implementation. Potential classification systems for use in the CAO update include the following types, which are discussed in greater detail below:

1. **Interim DNR Water Typing System** – A combination physical/biologically/beneficial use based classification system currently in use by Lewis County, this system uses five stream types (1 through 5), as described in Section 2.4.1.

2. **New DNR Water Typing System** — A combination physical/biologically based classification system, similar to the interim system, but using four stream types (S, F, Np, or Ns), as described in Section 2.4.1.

3. **Fish Species and Lifestage Stream Classification System** – A biologically based classification for streams or stream reaches based on salmonid use, including both species presence and life stage utilization (e.g., spawning, rearing, and migration).

4. **Aquatic Habitat Quality Based Classification System** – A habitat-based classification system for streams or stream reaches based on existing aquatic habitat condition and previously identified limiting factors.

5. **Combination Classification System** – A stream classification system combining elements of the above systems.

3.2.1 Interim DNR Water Typing System

The interim DNR water typing system is a common stream classification system in Washington State currently used by Lewis County and by many other jurisdictions for classifying streams. This system, discussed in Section 2.4.1, uses five stream types (1 through 5) and assigns stream classification based on the physical/biological/beneficial use of streams. Major components considered this system are a stream's status as a shoreline of the state, its size (OHWM greater or less than 20 feet), and fish presence within the stream.

A primary advantage of this system is the fact that it is a commonly used system within the state and the majority of Lewis County streams are already classified as geographic information systems (GIS) data according to this system, resulting in ease of implementation and application for County staff. Additionally, the system is widely understood by the public, since it is currently in use.

However, as the system was originally designed to type streams for forestry applications, it has several potential disadvantages as compared to a system based more exclusively on ecological function. For example, the interim DNR system classifies all shorelines as a Stream Type 1. Therefore, under the

Interim Water Typing System, a smaller tributary stream with a width of 25 feet and an annual mean flow of 22 cfs is classified into the same category as large rivers such as the mainstem Chehalis or Cowlitz, which are several hundred feet in width and have annual mean flows 3,000 cfs and 6,000 cfs, respectively. Obviously, the ecological functions provided by a riparian buffer in a small, headwater stream are significantly different than in the mainstem of a large river. For example, although the presence and quality of riparian vegetation plays a primary role in temperature regulation in a smaller stream, it is much less important for temperature regulation in large rivers, where upstream conditions, groundwater inputs, linear orientation may all play larger roles. Furthermore, the system uses some beneficial use designations, such recreation status (the number of campsites adjacent to a stream reach) to classify streams. Although applicable for water quality uses, this type of beneficial use is not directly or indirectly related to aquatic species presence, habitat quality, or ecological function.

3.2.2 New DNR Water Typing System

The new interim DNR water typing system, as described in Section 2.4.1, is a combination physical/biologically based classification system, very similar to the interim system, but only using four stream types (S, F, Np, or Ns). The primary difference is that the new DNR system does not differentiate between Type 2 and Type 3 waters, classifying all non-Shorelines of the State fish-bearing streams as Type F.

All waters within Washington State will eventually be typed using the new system. Furthermore, conversion between the new and interim systems is a relatively straightforward process. Therefore, the advantages of this system are similar to those discussed for the interim DNR water typing system.

Because only types of fish-bearing stream are classified using the new system, the potential disadvantages of considering a stream width of 25 feet, or recreation as a beneficial use, do not apply to this system. However, because the new system, like the interim system, still classifies all Shorelines of the State as Stream Type S, differing ecological functions are not fully addressed.

3.2.3 Fish Species and Lifestage Stream Classification System

The specific biological and ecological functions provided by individual streams differ substantially. Therefore, one potential classification system classifies stream reaches according to the fish species and life stages present within the reach. The presence of salmonids in various life stages within a stream or river reach can indicate or imply information on the habitat quality and quantity of that specific reach. For example, if a headwater stream reach supports bull trout, it may indicate that riparian buffer conditions within that reach are relatively intact, and the buffers are of sufficient size to provide for adequate moderation of water temperature and sediment filtration capability (since spawning bull trout require cool water and clean gravel). Likewise, a reach known to be occupied by spawning chum salmon can be assumed to be accessible to all other salmon species, since chum salmon are least powerful swimmers among the salmon.

This approach would use the WDFW PHS database to assign fish presence or life stage information. The database covers all of Lewis County and classifies stream reaches as spawning, rearing, or migration habitat for each individual salmonid species. Other reaches of stream, where site-specific information is lacking, are classified as presumed or historic habitat for a species.

The primary advantages of this system are in its biological and ecological relevance, coupled with a relatively complete, easily accessible database. However, there are several potential drawbacks to such a classification system. First, the link between fish presence and the quality or type of aquatic habitat is not complete. Dams, for example, can completely block anadromous fish access to high quality, productive, instream habitat. Second, fish presence/life stage information is currently incomplete, and may be biased toward easily accessed valley-bottom reaches as compared to more isolated headwater tributary reaches. Lastly, public understanding of the system may be lower, since buffers will vary based on fish distribution of multiple species and life stages.

3.2.4 Aquatic Habitat Quality Based Classification System

Another type of stream classification system is based on ecological functions, using known differences in habitat quality and limiting factors to classify streams. The relative quality and quantity of individual habitat parameters have direct correlation to the ecological functions that a particular stream reach or subbasin provide. This approach would rely on review of available reports on habitat conditions and limiting factors (e.g., LCFRB 2002; WSCC 2000, 2001) to assign a classification system based on the relative ecological condition of a stream reach or subbasin.

The primary advantage of such a classification system is that ecological relevance is built into the system. However, several disadvantages also are present because detailed, high-quality information on habitat quality is not available for many subbasins or reaches within Lewis County. Also, different sources of information have used different methods for previous habitat evaluations and classifications (Ecosystem Diagnostics and Treatment approach versus instream incremental flow methodology), resulting in information that is not directly comparable. Furthermore, in many cases this approach would require reliance on best professional judgment to combine information on multiple ecological functions in order to classify a particular stream or subbasin. Most likely, the approach would be most practical to apply at a larger spatial scale, such as the subbasin or subwatershed level, which could potentially negate the benefits by losing site of specific ecological functions due to the larger scale.

3.2.5 Combination Classification System

A final option for classifying streams involves combining several of the above methods. The option would allow tailoring of the classification system to the unique set of conditions present within Lewis County. For example, the basic classification could be based on the DNR stream typing systems; however, specific stream reaches or subbasins that are documented to contain especially important critical aquatic habitat or species could have a separate classification within the system. A combination approach could also potentially allow for maximum utilization of the available information on fish habitat conditions and fish distribution.

3.3 OPTIONS FOR ALLOWED USES

The Growth Management Hearings Boards have provided a variety of guidance relating to allowed uses that may affect critical area resources.

The broadest general guidance is the following:

> The discretion of a local government in designating and protecting Critical Areas is limited by the requirements to:
>
> (1) ensure compliance with the GMA,
>
> (2) protect Critical Areas,
>
> (3) ensure no net loss of Critical Area functions, and
>
> (4) include Best Available Science.

WWGMHB ICCGMC v. Island County 98-2-0023

The application of this policy to existing uses was addressed in a number of cases that generally require a higher level of review and control than would be the case for "non-conforming" uses under land use regulations:

> While RCW 36.70A.060 precludes prohibition of legally existing uses, regulation is still required by the GMA. A blanket exemption of existing uses from all protection is a disincentive to adequate protection of Critical Areas. *WWGMHB ARD v. Shelton 98-2-0005*
>
> Even if there is a GMA provision that precludes prohibition of pre-existing uses in critical areas, the GMA not only allows but also requires a local government to reasonably regulate existing activities that are shown in the record to be damaging to critical areas and their buffers. *WWGMHB FOSC v. Skagit County 96-2-0025*
>
> A local government must regulate preexisting uses in order to fulfill its duty to protect critical areas. GMA requires any exemption for preexisting use to be limited and carefully crafted. *WWGMHB PPF v. ClallamCounty 00-2-0008*

The scope of application was narrowed somewhat in the following decision as it applies to existing uses on lands that have been substantially altered and provide a limited range of ecological functions:

> After careful consideration of all the arguments, and the entire record, we are no longer convinced that the Act requires the County to mandate that regulation of critical areas provide for all the functions in every watercourse that contains or contributes to watercourses that contain anadromous fish in ongoing commercially significant agricultural lands where some of those functions have been missing for many years and where these functions are not required for a particular life stage of anadromous fish. By reaching the above conclusion, we are not saying that farmers do not need to alter their practices if they are continuing activities which will further degrade the streams. Those activities must stop and practices must be implemented which ensure no additional harm or further loss of function. *WWGMHB Swinomish Indian Tribal Community et al. v. Skagit County; 02-2-0012c*

There are a number of cases where intensity or appropriate scale of allowed uses have been addressed, including:

> Best Available Science in this record demonstrated that stream ecosystem impairment begins when the percentage of total impervious area reaches approximately 10 percent. A definition of minor new development which restricted the total footprint to 4,000 square feet and a total clearing area to 20,000 square feet removed substantial interference as to minor new development in Type 2, 3, and 4 waters. However, the county's failure to reduce footprint and clearing areas for rural lots smaller than 5 acres still fail to comply with the Act. *WWGMHB PPF v. Clallam* County 00-2-0008

Uses typically are limited within critical areas and their buffers that would be inconsistent with the ecological functions necessary for the resource. The existing Lewis County Code provides for the following allowed uses:

17.35.670 Allowed activities in streams and buffers.

(1) The following uses are specifically allowed in streams and buffer areas subject to the priorities, protection, and mitigation requirements of this article:

(a) Utility lines and facilities, regional transmission facilities, local delivery systems, and hydroelectric generating facilities where reasonable nonstream alternatives are unavailable;

(b) Public and private roadways and railroad facilities, including bridge construction and culvert installation, where reasonable nonstream alternatives are unavailable;

(c) Maintenance, repair, or operation of existing structures, facilities, or improved areas, including minor modification of existing serviceable structures within a buffer zone where modification does not adversely impact stream-based functions;

(d) Development activities allowed by permits issued in conjunction with LCC 17.35.700(1) and (2);

(e) Single-family residence and ordinary residential improvements on an existing legal lot within the buffer only where alternatives outside the buffer are unavailable;

(f) Regional storm water detention/ retention facilities, identified in an adopted plan of an appropriate public agency.

(2) The following uses might be necessary to fully enjoy and understand fisheries habitats or to provide resource activities and are permitted without any specific protection or mitigation other than may be identified in an applicable permit.

(a) Conservation, preservation, or enhancement projects to protect functions and values of the critical area system, including activities and mitigation allowed pursuant to the mitigation priorities identified in LCC 17.35.030(4);

(b) Outdoor recreational or educational activities which do not significantly affect the function of the fisheries habitat or regulated buffer (including wildlife management or viewing structures, outdoor scientific or interpretive facilities, trails, hunting blinds, etc.);

(c) Harvesting wild crops which do not significantly affect the function of the fisheries habitat or regulated buffer (does not include tilling of soil or alteration of fisheries habitat area);

(d) Existing and on-going agricultural activities, including maintenance of existing ditches and ponds;

(e) Golf courses in buffers only where at least 60 percent of the area of the required buffer is left undisturbed and at least required buffer is left undisturbed and at least 75 percent of the stream perimeter remains bounded by a minimum 25-foot-wide undisturbed buffer;

(f) Bank protection and flood protection, including flow control structures for regional retention/detention systems;

(g) In-stream fish and/or wildlife habitat enhancement.

(3) Stream relocation when a plan is submitted as part of the critical area study which demonstrates that the following criteria are met:

(a) The relocation will not significantly degrade water quality, fish or wildlife habitats, or aquifer recharge (if hydrologically connected to a wetland);

(b) The plan must contain and show the following information: a topographic survey showing existing and proposed topography and location of the new stream channel; and provisions for landscaping and long-term maintenance and for filling and revegetating the prior channel, if appropriate;

(c) Relocation will maintain or improve the functions and values of the fisheries habitat system;

(d) Natural materials and vegetation normally associated with the stream will be utilized;

(e) Spawning, rearing, and nesting areas will be created, if appropriate;

(f) Fish populations directly affected by the activity will be re-established, if appropriate;

(g) Current water flow characteristics compatible with fish habitat areas will be maintained. [Ord. 1170B, 2000; Ord. 1157, 1998; Ord. 1150 § 4.2(C), 1996]

The range of allowed uses is intended to limit effects on the resource. In many cases, the provision of specific mitigation may be required to limit impacts to acceptable levels. Specific uses that may require additional criteria and may require mitigation include the following:

- Existing and on-going agricultural activities, including maintenance of existing ditches and ponds may require criteria and conditions to meet WWGMHB criteria that agricultural practices must be modified if continuing activities would further degrade streams.
- The provision to allow golf courses in buffers must evaluate such mechanisms as LWD recruitment as well as application of herbicides and pesticides. It may be that with appropriate conditions, areas outside of fairways and greens could be acceptable within buffers.
- Bank protection and flood protection, including flow control structures for regional retention/detention systems has the potential for substantial effects on natural stream processes and may require extensive review based on criteria to preserve ecological functions and development of mitigation as part of the program.
- In-water structures such as docks are not specifically addressed by the existing code and warrant specific criteria and standards.
- Utility lines and facilities, specifically stream crossings, may be unavoidable for system connectivity and function. Additional criteria are warranted to evaluate alternatives and to more strictly limit facilities parallel to streams.
- Roads and railroads, including bridges may need to cross stream for viable connections to serve the community. Additional criteria are warranted to evaluate alternatives and to more strictly limit facilities parallel to streams.
- Maintenance, repair, or operation of existing structures, facilities where modification does not adversely impact stream-based functions should be clarified to include the range of ecological relationships between streams and uplands.
- The self-certification provisions in LCC 17.35.700(1) and the reliance on other agency permits in LCC 17.35.700 (2) should be replaced with a county mandate to review proposal for compliance with this code with provisions to coordinate conditions if other permits are required by other state or federal authority.
- Single-family residence and ordinary residential improvements on an existing legal lot within the buffer only where alternatives outside the buffer are unavailable are best addressed through a “reasonable use” provision, that may include individual mitigation or area wide mitigation provisions, if the range of potential impacts warrants.
- Regional storm water detention/ retention facilities, identified in an adopted plan of an appropriate public agency may be appropriate with mitigation to assure preservation of ecological functions.

3.4 BUFFER OPTIONS

As discussed above, buffers as used in this report function to some extent to separate incompatible uses from the habitat areas provide a variety of functions including:

- LWD recruitment
- Stream shading/temperature
- Bank stabilization/habitat formation
- Filtering of sediment, nutrients and chemicals
- Organic input and nutrient source
- Microclimate

There are a number of relevant Growth Management Hearings Board decisions addressing buffers including:

> The adequacy of a riparian buffer proposal is ultimately measured not by the characteristics of the buffer, but by the effect of that buffer on the fish habitat *WWGMHB, FOSC v. Skagit County 96-2-0025*.
>
> A standard 50-foot buffer for type IV and V waters, while at the low end of the range of scientific recommendations, achieved compliance because the buffers were within the range of BAS shown in this record. WWGMHB, *FOSC v. Skagit County 96-2-0025*
>
> A 25-foot riparian buffer zone even if it is a managed, compact buffer zone for ongoing agricultural activities in a designated ALR was below the range of BAS as shown by the record. It did not fall within the range of peer tested BAS in the record. *WWGMHB FOSC v. Skagit County 96-2-0025c*
>
> A CAO that exempts Type 4 and 5 non salmon-bearing waters and does not provide for any buffering of those types of streams is not within the range of BAS and does not comply with the Act. *WWGMHB FOSC v. Skagit County 96-2-0025c*
>
> An administrative discretion to reduce buffers by 25% and preclude gathering of information to justify greater buffer widths does not comply with the Act. *WWGMHB Diehl v. Mason County 95-2-0073*
>
> The overall intent of the pertinent sections of the GMA and WAC 365-190-020 is to assure no further degradation, no further negative impacts, and no additional loss of functions or values of critical areas. These sections focus on new activities and preventing new impacts or new degradation rather than requiring enhancement of existing conditions (*Swinomish Indian Tribal Community et al. v. Skagit County; 02-2-0012c*). For example RCW 36.70A.060(2) and .040(1) do not require buffers on all reaches of all watercourses containing anadromous fish (or those watercourses contributing to watercourses that do) to protect the existing functions and values of fish and wildlife habitat conservation areas in ongoing agricultural lands (*Swinomish Indian Tribal Community et al. v. Skagit County; 02-2-0012c [Compliance Order 12-8-03*]).
>
> Section 2 of this report provides a discussion of the range of functions provided by variation in the linear width of buffer zones. Tables 3-1 and 3-2 summarize this information in relation to the specific aquatic functions that are of greatest importance in maintaining conditions suitable to support fish and

other aquatic life (e.g., LWD recruitment, stream temperature, sediment filtration, etc.). For each buffer width, the suitability of the buffer is rated as to its ability to maintain these aquatic functions. Although this evaluation is qualitative, it is firmly based on BAS regarding ecological functions (see Section 2 for more detail). For the purposes of this comparison, the interim stream typing system (Types 1-5) was converted into the "new" DNR stream typing system (Types S, F, Np, and Ns).

These results are generally valid for relatively level or gently sloping sites. On steeply sloping sites, greater dimensions are appropriate for sediment and nutrient removal.

Table 3-1. Comparison of Functions of Riparian Buffer Widths for DNR Type S and Type F Streams

	Buffer Width				
Stream Function	**50 Feet** [1]	**100 Feet** [2,3]	**150 Feet**	**300 Feet**	**600 Feet**
Microclimate	X	X	N	P	F
Wildlife Habitat	N	P	P	P	F
LWD Recruitment	N	P	P	F	F
Pollutant Removal	N	P	P	P	F
Sediment Filtration	N	P	P	F	F
Water Temperature	N	P	F	F	F
Organic Litter	P	P	F	F	F
Bank Stability	F	F	F	F	F

KEY

F = Buffer width fully supports/maintains stream function

P = Buffer width partially supports/maintains stream function

N = Buffer width nominally supports/maintains stream function

X = Buffer does not adequately support/maintain stream function

1. Under current Code, Type 1 and 2 streams (approximately equivalent to Types S and F) in urban and rural areas with low-intensity land uses receive a 50-foot buffer.
2. Under current Code, Type 1 streams (equivalent to Type S) in urban and rural areas with high-intensity land uses receive a 100-foot buffer; Type 2 (approximately equivalent to Type F) rural streams in high-intensity land use areas receive a similar buffer.
3. Under current Code, Type 2 urban streams in high-intensity land use areas receive a 75-foot buffer

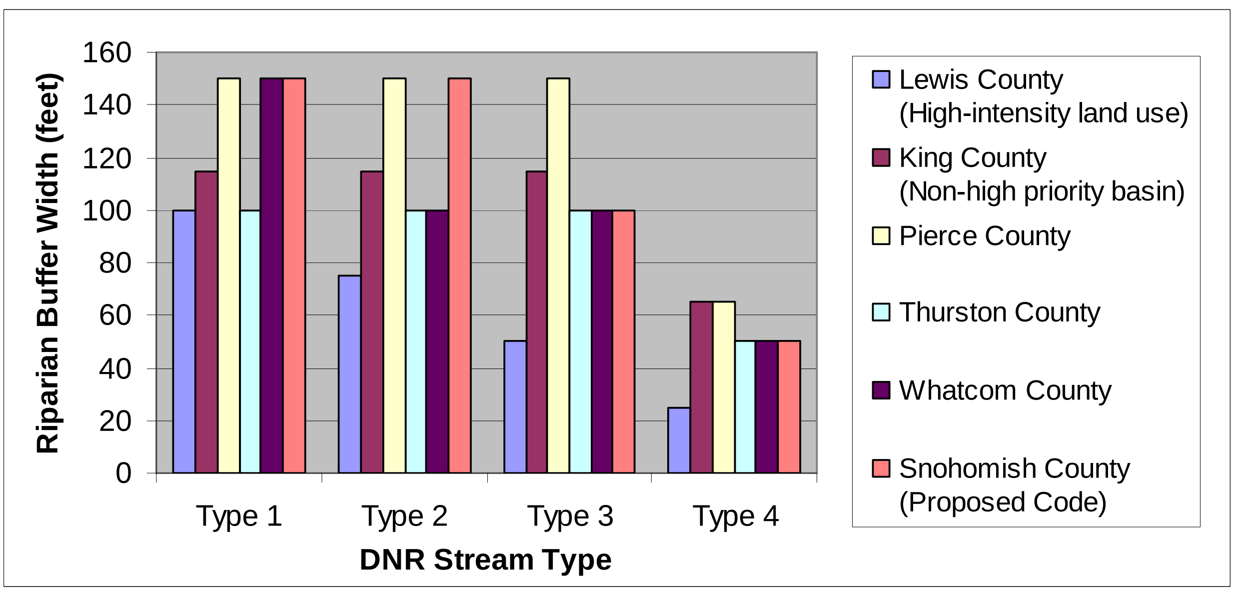
Some riparian buffer widths used in the CAOs of several western Washington Counties are shown in Figures 7 and 8. The buffers are based on the DNR classification system, and are shown for urban streams (Figure 7) and rural streams (Figure 8). The figures indicate that there is a range of adequate buffer widths supported by BAS and case law. However, based on BAS and case law, certain minimum buffers must be present in order to ensure no net loss of ecological function. For example, *FOSC v. Skagit County 96-2-0025c* [(Compliance Order, 8-9-00) & *FOSC v. Skagit County 00-2-0033c* (Final Decision and Order, 8-9-00)] found that a 25-foot riparian buffer zone did not fall within the range of peer-tested BAS in the record.

Table 3-2. Comparison of Various Riparian Buffer Widths for DNR Type Np and Ns Streams

	Buffer Width						
Stream Function	**10 Feet [1]**	**25 Feet[2]**	**50 Feet[3]**	**100 Feet**	**150 feet**	**300 feet**	**600 feet**
Microclimate	X	X	X	X	N	P	F
Wildlife Habitat	X	X	N	P	P	P	F
LWD Recruitment	X	X	N	P	P	F	F
Pollutant Removal	X	N	N	P	P	P	F
Sediment Filtration	X	N	N	P	P	F	F
Water Temperature	X	N	P	P	F	F	F
Organic Litter	X	N	P	P	F	F	F
Bank Stability	X	N	F	F	F	F	F

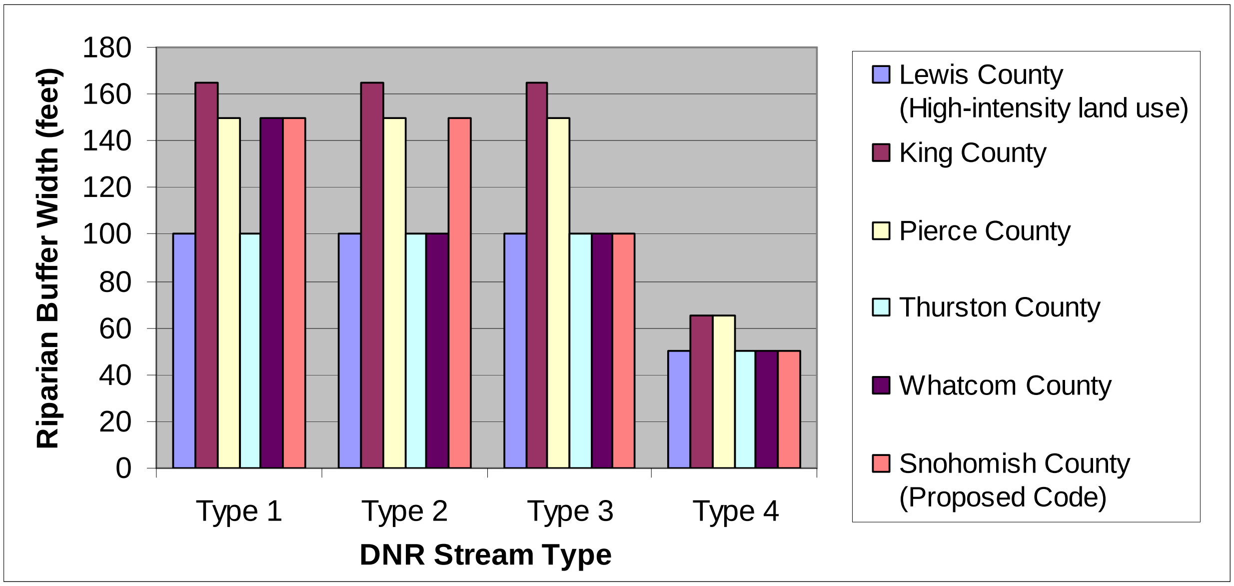
KEY
F = Buffer width fully supports/maintains stream function
P = Buffer width partially supports/maintains stream function
N = Buffer width nominally supports/maintains stream function
X = Buffer does not adequately support/maintain stream function
1. 10 Feet - Existing Lewis County Code - Type 5 Low and High Intensity Urban
2. 25 Feet - Existing Lewis County Code - Type 5 Rural and Type 4 Urban / Low Intensity Rural
3. 50 Feet - Existing Lewis County Code - Type 4 High Intensity Rural

Figure 7. Current and Proposed Critical Areas Riparian Buffer Widths in Urban Areas for Several Washington Counties



Notes:
In Lewis County, existing code allows for buffer averaging and buffer reduction in certain cases.
In King County, the buffer is extended to 165 feet for Type 1 through 3 streams located in a basin or shoreline designated as "high" on the Basin and Shoreline Conditions Map. Code allows for buffer averaging in certain cases, but no buffer reduction.
In Pierce County, the buffer may be extended if it is located adjacent to a landslide area. Code allows for buffer averaging, buffer reduction, or buffer increases in certain cases.
In Thurston County, code allows for buffer reduction in certain cases.
In Whatcom County, code allows for buffer averaging and buffer reduction in certain cases.
In Snohomish County, proposed code indicates that buffer for Type 3 streams may be reduced to 50 feet, if no resident or anadromous salmonids are present. The proposed code allows for buffer averaging and buffer reduction in certain cases.

Figure 8. Current and Proposed Critical Areas Riparian Buffer Widths in Rural Areas for Several Washington Counties



Notes:
In Lewis County, existing code allows for buffer averaging and buffer reduction in certain cases.
In King County, code allows for buffer averaging in certain cases, but no buffer reduction.
In Pierce County, the buffer may be extended if it is located adjacent to a landslide area. Code allows for buffer averaging, buffer reduction, or buffer increases in certain cases.
In Thurston County, code allows for buffer reduction in certain cases.
In Whatcom County, code allows for buffer averaging and buffer reduction in certain cases.
In Snohomish County, proposed code indicates that buffer for Type 3 streams may be reduced to 50 feet, if no resident or anadromous salmonids are present. The proposed code allows for buffer averaging and buffer reduction in certain cases.

Using this approach, the BAS review of aquatic habitat functions and values in Section 2 will be used to set buffer widths that will be protective of specific aquatic functions. However, there are several different approaches on how to structure and implement buffers while remaining consistent with the goals of the CAO.

Potential riparian buffer frameworks for use in the CAO update include the following types, which are discussed in greater detail below:

1. **Standard Single Zone Buffers** – Fixed-distance stream buffers based on the maintenance of individual aquatic functions. The buffer widths may be further divided by land use (e.g., urban versus rural) or by other variables.
2. **Dual Zone Buffers** – This approach utilizes two smaller adjacent buffer zones that, when combined, make up the overall riparian buffer. An inner "core" zone, directly adjacent to the aquatic feature, consists of an area where uses are prohibited or severely restricted. In the outer riparian zone, adjacent to the core zone, uses are still restricted, but to a lesser degree.
3. **Combination Single Zone and Dual Zone Buffers** – This approach would allow the applicant to choose from a smaller single-zone buffer, where uses are prohibited or severely restricted, or an expanded dual-zone buffer, in the which the (more restrictive) inner core zone is somewhat smaller than for the single zone, but the outer buffer zone (where limited uses are allowed) is expanded to protect aquatic functions at an equal scale.

All of the above approaches could potentially incorporate buffer averaging techniques, in cases where the overall buffer area will be equal to un-averaged conditions and it can be clearly demonstrated that averaging will result in no net loss of aquatic functions.

3.4.1 Standard Single Zone Stream Buffers

Single-zone buffers are the most common type of riparian buffer, with a designated minimum buffer for each class or type of stream/habitat as defined by the applicable Stream Classification scheme. If the interim DNR classifications are used, the appropriate buffers would be in the range of 100 to 150 feet for fish-bearing streams (DNR Types 1 through 3) and no less than 50 feet for non-fish bearing streams (DNR Types 4 and 5), based on BAS and previous legal reviews.

In addition, LCC 17.35.680 indicates the stream buffers for defined low-intensity uses are significantly less than for high-intensity uses. Low-intensity uses are defined as those that have a low or moderate impact on the environment. These uses include residential uses with less than 35 percent impervious surface of the parcel, and commercial uses with less than 50 percent impervious surface (and all stormwater treated to County standards). Section 2.2.8 indicates that, on a watershed level, negative effects to aquatic habitat occur at threshold impervious surface values of 10 to 15 percent. Therefore, if the updated CAO still designates stream buffers according to low- and high-intensity uses, it appears the definition of these categories will need to be revised, based on BAS and previous legal reviews.

In additional, in order to meet the requirements of GMA, Lewis County should consider the following factors in establishing stream buffers.

- The stream buffer should be measured horizontally in a landward direction from the OHWM.
- Special consideration should be given to stream buffer areas encompassing CMZs. This may include measuring the stream buffer from the edge of the CMZ (if wider than OHWM), at least in the case where priority CMZs within the County have been identified.
- Where lands immediately adjacent to a stream are classified as geologically hazardous areas, landslide hazard areas, and/or erosion hazard areas, the recommended buffer should extend for a certain distance (e.g., 25 or 50 feet) beyond the top of the steep slope for fish-bearing streams, and to the top of the slope for non-fish bearing streams.
- In cases where a legally established roadway passes through an aquatic area buffer, the roadway edge closest to aquatic area should be the extent of the buffer, if the part of the buffer on the other side of the roadway is shown to provide insignificant biological or hydrological function in relation to the portion of the buffer adjacent to the aquatic area.
- Buffer averaging should be allowed only in cases where the overall buffer area is not reduced and averaging will not reduce the overall riparian functions provided. For any part of the averaged buffer, a minimum buffer width, based on both absolute distance and percentage reduction of the standard buffer, should be established.

The advantages of single-zone stream buffers are that (1) they are the most common buffer type and have had extensive BAS and legal review, (2) they are relatively simple to understand from a public standpoint and lend themselves to straightforward and efficient administrative processing, and (3) this type of buffer allows for buffering averaging.

One disadvantage of such a system is that riparian buffers are not uniform in the functions they provide relative to the width of the buffer. For example, the riparian functions of bank stability and litter fall are primarily provided for within a relatively short distance of a waterbody (10 to 50 feet). Increasing the buffer distance does not necessarily improve these specific riparian functions. For example, impacts to the outer 25 feet of a 100-foot-wide buffer would likely have much less impact to bank stability and litter fall functions than would identically scaled impacts directly adjacent to the stream. In summary, a single-zone buffer does not easily allow for different impact types within different parts of the buffer, while a dual-zone buffer does.

3.4.2 Dual Zone Stream Buffers

This approach, commonly used in forestry applications, is similar to the single zone stream buffer (see above). However, the overall stream buffer is composed of two smaller adjacent buffer zones, which when combined make up the overall riparian buffer. The two zones are:

- An inner "core" buffer zone, located directly adjacent to the aquatic feature. In this area landuses are prohibited or severely restricted.
- An outer riparian zone, landward and adjacent to the core zone, where land uses are still restricted, but to a lesser degree than within the core area.

Dual zone buffers are not as common as single-zone buffers and are more complex from a public understanding and County administrative standpoint, although buffer averaging could still occur within the outer riparian zone.

The primary advantage of this type of buffer system is that the dual zone system incorporates BAS indicating that riparian buffers are not uniform in the functions they provide relative to the width of the buffer. For example, for a relatively small stream that supports salmonid rearing and has a mixed forest riparian buffer, a continuous buffer width of 75 to 100 feet may be adequate to support the aquatic functions of LWD recruitment, temperature regulation, and the provision of detritus and nutrients to the stream. The segment of the buffer from 100 to 150 feet still supports important ecological functions such as pollutant filtration and microclimate regulation, but in this outer area a solid homogeneous buffer may not be required to support these functions to a high degree. In summary, as compared to a single zone buffer, a dual zone buffer may allow for different impact types within different parts of the buffer.

Examples of specific ecologically relevant provisions that could be applied to the outer buffer zone include:

- A limit to the amount of clearing allowed within the outer buffer zone.
- A minimum amount of forest required to be retained within the outer buffer zone.
- A limit to the amount of impervious surface allowed within the outer buffer zone.
- A limit to the development density allowed within the outer buffer zone.

3.4.3 Combination Single Zone and Dual Zone Buffers

This approach would allow the applicant to choose from two approaches, both designed to maintain ecological functions to a similar degree. The applicant would have a choice to either

1. Use the single zone buffer, where land uses are prohibited or severely restricted, or

2. Use a dual zone buffer, in which the (more restrictive) inner core zone is somewhat smaller than for the single zone buffer (#1 above), but the outer buffer zone (where limited uses are allowed) is expanded to protect aquatic functions at an equal scale.

In this system, the overall buffer width for the combined dual zone buffers would be wider than for the single zone buffer, because more uses are allowed within the outer portion of the dual zone buffer. This approach has the advantage that it is adaptable to a wide range of land use activities, and gives the applicant choice on which approach is best suited to their particular situation, while still maintaining equal levels of aquatic habitat functions for the overall system. A disadvantage of the system is that it may be somewhat more difficult to administer, as compared to a single buffer approach.

3.4.4 Comparison of Potential Stream Classification and Buffer Systems

Several alternative stream classification and buffer systems have been presented above. If implemented correctly, all of the systems can meet the requirements of the GMA. However, potential differences exist between these systems as to administrative issues, public understanding, and the ease of implementation. Tables 3-3 and 3-4 give conceptual comparisons of some of these parameters between the various classification and buffer systems presented. However, it should be noted that this comparison is strictly qualitative and based largely on best professional judgment.

Table 3-3. Comparison of Stream Classification Systems

	Stream Classification System			
Parameter	**Interim DNR Water Typing System**	**New DNR Water Typing System**	**Fish Species and Lifestage Stream Classification System**	**Aquatic Habitat Quality Based Classification System**
Commonly Used / Previously Approved	H	H	M	M
Ease of Public Understanding	H	H	M	M
Ease of County Application	H	H	M	M
Linkage to Aquatic Species	M	M	H	M
Linkage to Aquatic Habitat	L	L	M	H
Classification System Currently Delineated	H	H	M	L
Readily Available Information for Classification	H	H	M	M

Key: L = Low, M = Moderate, H= High

Table 3-4. Comparison of Stream Buffer Systems

	Stream Buffer Type		
Parameter	**Standard Single Zone Buffers**	**Dual Zone Buffers**	**Local/ Watershed Riparian Conditions**
Ease of Public Understanding	H	M	M
Ease of County Application	H	M	L
Allows for County-Wide Mapping	H	M	L
Commonly Used / Previously Approved	H	M	L
Related to Aquatic Functions (General and Local)	M	M	H
Related to Site Specific Functions	L	L	H
Compatible with Buffer Averaging	H	M	L

Key: L = Low, M = Moderate, H= High

3.4.5 Recommended Stream Classification and Buffer Systems

3.4.5.1 Recommended Stream Classification System

In order to provide for ease of understanding, application, and general understanding use of the DNR classification system is recommended as the system currently available that best meets the needs of county and the public. A modification of the Type F Waters is proposed into streams with a width of greater and less than 10 feet, to recognize that certain functions may adequately be provided on smaller streams within a smaller buffer area.

If information is developed in the future that allows a comprehensive classification of steams based on geomorphic character and existing species use, such a system would be preferable. The information available, however, does not allow development of such a system. Considerable research and testing would be required to develop such a system. To be valid, such a system should be developed on a regional scale and likely would require several decades of research.

3.4.5.2 Recommended Stream Classification and Buffer Systems

The recommendations below are based on the judgment that the following functions are most critical for the following classification of streams:

Table 3-5. Recommended Stream Buffer Dimensions

Stream Type	Standard Single Zone Buffers	Reduction with Additional Conditions
Type S Water - "shorelines of the state" per 90.58 RCW	150	100
Type F – A Water – waters other than Type S Waters that contain fish habitat and have width of greater than 10 feet.	150	100
Type F – B Water – waters other than Type S Waters that contain fish habitat and have a width of less than 10 feet.	100	75
Type Np Water - natural waters that are perennial nonfish habitat streams.	75	50
Type Ns Water - seasonal, nonfish habitat streams	75	50

In all cases, where buffers are less than 100 feet and slopes within the buffers above exceed 25 percent, the buffer would extend to a 30 percent greater dimension. Where slopes within the buffers above exceed 35 percent, the buffer would extend to 25 feet above the top of slope, or if a landslide hazard buffer is present, to whichever is greater.

Type S Water - "shorelines of the state" per 90.58 RCW: These streams range upward from flows of 20 csf. Generally they have well defined stream channels, often have floodplains, generally are at least 20 feet wide (except where restricted by natural or man-made barriers) and provide substantial fish habitat and a variety of habitat for species that rely on the water for at least a portion of their lifecycle.

The function that is judged to be the primary limiting factor for such streams is LWD recruitment which is critical for the basic geomorphologic structure of the stream. Other functions that are provided by buffers sufficient to provide LWD recruitment also provide:

- Sediment filtration, except for on steep slopes;
- Pollutant removal; except for on steep slopes;
- Maintenance of shade for water temperature attenuation

- Organic litter for aquatic life cycle support
- Bank Stability
- Wildlife Habitat

The major function that is not provided is microclimate. Microclimate is likely to be substantially provided on sites where the adjacent use is timber management during most of the timber management lifecycle. Microclimate functions on timberland would not be provided for a period of about a decade after substantial harvest (although the Shoreline Management Act limitation of a 30 percent cut would lead to some retention of this function). In areas of the county not in timber management, microclimate functions are not likely to be present, and therefore management for that function is not likely to provide a substantial benefit. LWD Recruitment.

Type F Water A – Fish bearing streams other than shorelines with a width of greater than 10 feet. These streams have well defined stream channels, often have floodplains, and provide substantial fish habitat and a variety of habitat for species that rely on the water for at least a portion of their lifecycle.

The function that is judged to be the primary limiting factor for such streams is LWD recruitment which is critical for the basic geomorphologic structure of the stream. Other functions that are provided by buffers sufficient to provide LWD recruitment are as listed for Type S waters, above.

Type F Water B – Fish bearing streams other than shorelines with a width of less than 10 feet. These streams have well defined stream channels, often have floodplains, and provide substantial fish habitat and a variety of habitat for species that rely on the water for at least a portion of their lifecycle. Because of their smaller width and less flow, they are likely to have somewhat less total productivity, but on a watershed basis, the large number of stream miles is likely to make these a very important resource

The function that is judged to be the primary limiting factor for such streams is LWD recruitment which is critical for the basic geomorphologic structure of the stream, however the smaller size of the stream generally requires less total wood recruitment to provide this function. Since the majority of recruitment is provided closer to the stream, a smaller buffer dimension is warranted. Other functions that are provided by buffers sufficient to provide LWD recruitment are as listed for Type S waters, above.

Type Np Water - natural waters that are perennial nonfish habitat streams provide important functions to fish bearing streams related largely to providing water that is clean and at the proper temperature. These streams also provide habitat for other aquatic organisms that are important to overall ecological functions. The functions that are judged to be the primary limiting factors are:

- Sediment filtration, except for on steep slopes;
- Pollutant removal; except for on steep slopes;
- Maintenance of shade for water temperature attenuation
- Organic litter for aquatic life cycle support
- Bank Stability, which also relates to geomorphic functions.
- Wildlife Habitat

Type Ns Water - seasonal, nonfish habitat streams may provide flows during higher rainfall times of year important to fish bearing streams related largely to providing water that is clean and at the proper temperature. The functions that are judged to be the primary limiting factors are the same as for NP streams. The sediment and pollutant inputs that are likely to adversely impact fish bearing streams.

Type S and Type F-A Streams: Buffer Reduction with Additional Conditions

The provisions for reduction of buffers for Type S and F-A streams is recognition that LWD (Recruitment) can be augmented by management to produce comparable results to a larger buffer.

Within mature Western Washington lowland coniferous forests, between 70 and 90 percent of LWD recruitment occurs within 100 feet of the stream on site that are flat or at a gentle gradient. For sloping site, recruitment occurs at a greater distance due to the distance trees can be transported downhill. Therefore, within fish bearing streams of Lewis County, a buffer width of 100 feet, if it consists of dense, mature coniferous forest, would provide adequate shading and an adequate supply of LWD. Relative density (Curtis 1982), a measure of the density of trees in a given stand is an accurate measure of occupied growing space, and is sensitive to tree age and size. High relative density denotes a dense canopy forest with high shade. The following equation is used to calculate relative density:

Relative Density = Basal Area / Quadratic Mean Diameter -0.5

Within Douglas fir forests of the Pacific Northwest, research has shown that a relative Density of 20 is the lower limit of canopy closure in unmanaged stands (Drew and Flewelling 1979; Curtis 1982).

The recommended general buffer width of 150 feet for DNR type S and F streams is designed to provide a simple standard that is applicable across a range of slopes and a range of existing conditions. This standard will provide some additional LWD recruitment on sites where slope abut streams, and also will provide additional margins of productivity for sediment removal and nutrient cycling on slopes sites. The larger standard also provides some compensation for the wide variation in the type, density and age of trees in riparian buffers. Other functions provided at a level that fully supports function is shade for water temperature (provided native tree canopy is available) Functions that are partially provided include sediment and pollutant removal, which are slope and vegetation dependent and are more fully provided non flat or gently sloping sites with established native vegetation. Wildlife habitat is partially supported, but may be fully maintained where adjacent low and moderate intensity uses provide some permeability for wildlife movement and some wildlife functions. This is generally the case for resource lands and large lot rural use.

An alternative approach may pursued that reduces the buffer to 100 feet, but includes additional standards to assure that individual sites provide adequate tree population to provide LWD over time. The short term (up to 50 year) result of such a policy would be to reduce the additional recruitment that occurs on sloping sites and sites with mature trees at a high density. Over the long term (50 years and greater) such a program to assure tree density closer to streams would likely result in higher overall LWD recruitment. Other functions provided at a level that fully supports function is shade for water temperature which would be assured by tree canopy at a relative density of 20 or over the long-term by planning. Functions that are partially provided including sediment and pollutant removal, which are slope and vegetation dependent would be enhanced by assurance or establishment of native vegetation. Wildlife habitat is partially supported, but may be fully maintained where adjacent low and moderate intensity uses provide some permeability for wildlife movement and some wildlife functions. For high intensity uses, the lack of use of adjacent land, and proximity impacts, wildlife functions of a 100 foot buffer would be compromised. Therefore it is recommended that this provision not be allowed for those uses.

To achieve this result the following conditions are met:

1. Documentation is provided from a forester who has surveyed the site indicating the species composition, basal area, and quadratic mean diameter of trees within the parcel and including calculation of relative density.
2. The calculated relative density of forest within the 100 feet of the riparian buffer closest to the stream is greater than 20.

3. If the relative density is less than 20, the landowner supplements the riparian zone within 100 feet of the riparian buffer closest to the stream by planting or under-planting with native coniferous seedlings. The required planting densities will result in a post-planting (simple) density of not less than 300 trees per acre (including existing coniferous and deciduous trees greater than 6-inches in diameter).
4. Tree survival will be monitored annually for 5-years following planting, with annual monitoring reports provided to the Lewis County Department of Community Development. Tree survival will be a minimum of 80 percent over length the monitoring period. If tree survival falls below 80 percent during any part of the monitoring period, additional planting will occur to ensure 80 percent or greater survival.

Type F-B Streams, Buffer Reduction with Additional Conditions

The provisions for reduction of buffers for Type F – B streams also is recognition that both LWD (Recruitment) and temperature attenuation can be augmented by management to provide a more effective tree cover. The 75 foot recommended buffer width is based on the smaller width of the stream and the need for less recruitment. Other functions provided at a level that fully supports function is shade for water temperature which would be assured by tree canopy at a relative density of 20 or over the long-term by planning. Functions that are partially provided including sediment and pollutant removal, which are slope and vegetation dependent would be enhanced by assurance or establishment of native vegetation. Wildlife habitat is partially supported, but may be fully maintained where adjacent low and moderate intensity uses provide some permeability for wildlife movement and some wildlife functions. For high intensity uses, the lack of use of adjacent land, and proximity impacts, wildlife functions of a 75 foot buffer would be compromised. Therefore it is recommended that this provision not be allowed for those uses.

Type Np and Ns Streams, Buffer Reduction with Additional Conditions

The provisions of buffers for Type Np and Ns streams is based primarily on water quality. The provision for reduction is based on recognition that the functions of sediment and nutrient removal, and the provision of shade can be provided in a smaller dimension, if tree cover and groundcover is augmented by management. In order to accomplish this, the buffer reduction measures are limited to sites with slopes of less than 15 percent and the following additional standards:

3.a. If the relative density is less than 20, the landowner supplements the riparian zone within 100 feet of the riparian buffer closest to the stream by planting or under-planting with native coniferous seedlings. The required planting densities will result in a post-planting (simple) density of not less than 300 trees per acre (including existing coniferous and deciduous trees greater than 6-inches in diameter).

3.b. Native understory must be present or installed throughout the buffer area at densities characteristic of native evergreen forests. If understory is required to be planted, erosion control measures such as mulch will be required until native understory is fully functional.

Fifty (50) feet is the minimum dimension in which sediment and nutrient removal can reasonably be expected to be reliably accomplished over a range of site conditions. The assurance of relative density of existing vegetation, or provision for planning will enhance this function. Other functions provided at a level that fully supports function is shade for water temperature which would be assured by tree canopy at a relative density of 20 or over the long-term by planning. Wildlife habitat is partially supported, but may be fully maintained where adjacent low and moderate intensity uses provide some permeability for wildlife movement and some wildlife functions. For high intensity uses, proximity impacts such as light and glare can be expected to greatly compromise wildlife functions of a 50 foot buffer. Therefore it is recommended that this provision for reduction not be allowed for those uses.

The recommended definition of intensity of uses is:

Low intensity uses and activities provide a context in which many of the ecological functions common to critical areas can function on adjacent land use outside of the protected area. Land alteration is slight and human activities are either very infrequent or at a low level of intensity. Wildlife habitat functions in particular are accommodated to a large extent on adjacent land and may include breeding and nesting/denning as well as foraging.. Low intensity use, facilities and activities include

- Forestry
- Low-intensity open space (hiking, bird-watching, preservation of natural resources, etc.)
- Unpaved trails
- Utility corridor without maintenance roads and little to no vegetation management.

Moderate intensity uses and activities provide a context in which a moderate number and quality of ecological functions, particularly wildlife habitat, can occur on adjacent land devoted to these uses.. The proximity impacts of such uses are either of limited frequency, of a low level, or widely dispersed along the boundary of the buffer. Wildlife habitat uses of foraging in particular are accommodated to a moderate degree on adjacent land. Moderate intensity uses, facilities and activities include:

- Residential use at 1 unit/acre or less
- Moderate-intensity open space (parks with biking, jogging, etc)
- Agriculture uses involving little soil exposure and characterized by crops such as orchards and pasture with animal density of less than one animal unit per acre.
- Paved trails
- Logging roads and farm access roads that are unpaved and used primarily for access to forests or farmland on less than a daily basis, except during harvest periods
- Utility corridor or right-of-way shared by several utilities and including access/maintenance road

High intensity uses and activities provide a context in which few, if any ecological functions occur on land devoted to these uses. Few if any wildlife habitat functions are provided on lands subject to high intensity activities. The proximity impacts of such uses are great and require buffering for attenuation. High intensity uses, facilities and activities include:

- Residential use at 1 unit/acre or greater
- Commercial
- Industrial
- Institutional
- Retail sales
- High-intensity recreation (golf courses, ball fields, etc.)
- High-intensity agriculture such as dairies, nurseries, green houses, growing and harvesting crops requiring annual tilling, raising and maintaining animals at a density of greater than 1 animal unit per acre, etc.)

3.4.5.3 Stormwater Management

To assure adequate water quality from moderate and high intensity development, Lewis County should adopt stormwater management standards based on the 2005 Department of Ecology Stormwater Management Manual for Western Washington. This would involve:

- Flow management using the "duration" standard in the current manual rather than the "peak" standard currently used;
- Water quality standards in the new manual are more effective for both source control and treatment.

4. FINDINGS AND CODE RECOMMENDATIONS

The following tables summarize the findings and proposed recommendations for revising LCC 17.35 to address GMA requirements for FWHCAs in Lewis County. These recommendations are based on the best available science review outlined above. The recommendations are grouped into general policy-related recommendations and recommendations for specific regulatory protections.

4.1 GENERAL FINDINGS AND RECOMMENDATIONS

Section LCC 17.35 establishes the overall framework for the County's habitat protection regulations. This section identifies and designates the species and habitats that are subject to the code requirements in accordance with GMA guidelines.

Habitats and species of local importance are not defined as a FWHCA in LCC 17.35. The Lewis County Critical Areas Technical Group (CATG) recommended inclusion of the species: Western Brook Lamprey, Pacific Lamprey, Western Toad and Fresh Water Mussles. Management programs, such as buffers, recommended for other species should protect these species as well, with the exception of Western Toad that has an extensive on-land lifecycle period that would require provisions in the terrestrial habitat section. In addition, other counties provide a process for nominating and designating a species or habitat of local importance. In Skagit County an individual or group may petition the County to designate a species or habitat as locally important if the species/habitat is in decline, is sensitive to habitat alteration, and is of social value; if feasible management measures are included in the petition; and mapped (1:24,000 scale) locations are provided.

General Habitat Findings and Recommendations	
Finding	1. LCC does not specify that special consideration must be provided for anadromous fish species as specified in the GMA 2. Lands containing species and habitats of local importance are not included as a category of fish and wildlife habitat conservation areas in LCC 17.35.195 The CATG recommended the species: Western Brook Lamprey, Pacific Lamprey, Western Toad and Fresh Water Mussles. Management programs, such as buffers, recommended for other species should protect these species as well.
Recommendation	1. Include language that special consideration be afforded to anadromous fish species and habitats and include in LCC 17.35.020. 2. Identify as fish species and habitat of local importance in LCC 17.35.195 • Western Brook Lamprey, • Pacific Lamprey, • Western Toad and • Fresh Water Mussles

Timing Restrictions	
Finding	1. Timing restrictions for instream work are not specified in LCC and there is no provision stating that timing restrictions established by other agencies be adhered to.
Recommendation	1. LCC should specify that all in-water work timing will be consistent with approved fish work windows determined by WDFW and presented in the WAC, including any deviations afforded by emergency or special circumstances as does WDFW.

4.2 RECOMMENDATIONS FOR REGULATORY REQUIREMENTS (PROTECTION AND MANAGEMENT)

The existing provisions of LCC 17.35 include relatively broad performance standards with few prescriptive requirements. Many of the regulatory standards in LCC 17.35 give considerable discretion to staff, which allows flexibility during the development review process but may also result in insufficient or inconsistent management approaches. The challenge of interpreting some of the existing regulations may be exacerbated by gaps in the code, namely the lack of specific buffer standards for habitat types other than streams and rivers; lack of specific mitigation requirements to compensate for adverse effects on aquatic species or habitats; and lack of specificity as to how effects on aquatic species and habitats are to be measured, reported and/or monitored. The County may improve protection and management of fish habitat critical areas by adding prescriptive standards that address the size, amount, location, configuration, and other habitat characteristics that are needed to maintain populations of target species in Lewis County.

Stream Classification System	
Finding	**1.** Any stream classification system should be based on factors ecologically relevant to the critical species and habitats they address. LCC 17.35.660 classifies streams based on DNR interim stream types (Types 1 through 5), which is primarily based on fish usage, stream flow, and channel size. Although this system is commonly used and is relatively well mapped, other potential stream typing systems may provide a greater degree of direct correlation to the aquatic ecosystem (fish usage by species/life stage, relationship to aquatic habitat conditions) and address the specific aquatic functions that these streams support. Classification systems that may be evaluated include the following: • Interim DNR Water Typing System • New DNR Water Typing System • Fish Species and Lifestage Stream Classification System • Aquatic Habitat Quality Based Classification System • Combination Classification System **2.** The stream classification system in LCC 17.35.660 does not explicitly classify streams based on the presence anadromous fish species (as specified in the GMA).
Recommendations	Adopt the DNR classification system for greater consistency with other applications and ease of administration.
Allowed Uses	
Findings	Allowed uses provide for some uses that may lead to adverse effects on ecological functions unless appropriately developed and mitigated
Recommendations	For allowed uses, provide more specific criteria for cases when they may be allowed and provide specific authority for mitigation for the following: • Existing and on-going agricultural activities, including maintenance of existing ditches and ponds may require criteria and conditions to meet WWGMHB criteria that that agricultural practices must be modified if continuing activities would further degrade streams. • The provision to allow golf courses in buffers must evaluate such mechanisms as LWD recruitment as well as application of herbicides and pesticides. It may be that with appropriate conditions, areas outside of fairways and greens could be acceptable within buffers. Recommend that provisions be included for special management plans for recreation uses in General Provisions. • Utility lines and facilities, specifically stream crossings, may be unavoidable for power system connectivity and function. Additional criteria are warranted to evaluate alternatives and to more strictly limit facilities parallel to streams. • Roads and railroads, including bridges may need to cross stream for viable connections to serve the community. Additional criteria are warranted to evaluate alternatives and to more strictly limit facilities parallel to streams.

Allowed Uses	
Recommendations (continued)	• Maintenance, repair, or operation of existing structures, facilities where modification does not adversely impact stream-based functions should be clarified to include the range of ecological relationships between streams and uplands. • The self-certification provisions in LCC 17.35.700(1) and the reliance on other agency permits in LCC 17.35.700 (2) should be replaced with a county mandate to review proposal for compliance with this code with provisions to coordinate conditions if other permits are required by other state or federal authority. • Single-family residence and ordinary residential improvements on an existing legal lot within the buffer only where alternatives outside the buffer are unavailable are best addressed through a "reasonable use " provision, that may include individual mitigation or area wide mitigation provisions, if the range of potential impacts warrants. Regional storm water detention/ retention facilities, identified in an adopted plan of an appropriate public agency may be appropriate with mitigation to assure preservation of ecological functions.
Recommendations	
Finding	LCC 17.35.660 classifies stream buffers as a single width zone based on stream type and proposed land use. Although this system is commonly used and is relatively easily applied, other ways of assigning buffers may provide a greater ecological relevance and better preserve the specific aquatic functions at a site-specific level.
Recommendation	Use standard single-zone buffers as in the current code for ease of communication and administration. The land use intensity system is not relevant to the types of functions provided by buffers except for proximity impacts, which relate primarily to wildlife use.
Finding	Existing stream buffers are 50 to 100 feet for salmon-bearing streams and 10 to 50 feet for non-salmon-bearing streams. A 150-foot or greater buffer is generally considered adequate for protecting most riparian habitat functions and stream morphology features based on LWD Recruitment as a key geomorphic process.. Based on BAS, riparian functions (most notably LWD recruitment) generally cannot fully be provided by 50- to 100 foot buffers. Reduction of buffers to approximately 100 feet may be justified if the relative density of vegetation meets certain standards through existing vegetation or planting to achieve long-term shading and LWD recruitment. These buffer widths are somewhat narrower than those established by other jurisdictions who have recently updated their CAOs.
Recommendations	Assign buffer widths of adequate size to support key individual aquatic functions. For Shorelines and other Type F fish-bearing streams with a width of 10 feet or greater, establish a standard of 150 feet and allow reduction of buffers to 100 feet with low and moderate intensity adjacent use, if the relative density of vegetation meets certain standards through existing vegetation or planting to achieve long-term shading and LWD recruitment. Provide buffers of 100 feet for Type F streams with a width of less than 10 feet with provision for reduction to no less than 75 feet with low and moderate intensity adjacent use, if vegetation is sufficient for sediment and nutrient control and shading. Provide buffers of 75 feet for Type Np and Ns non fish bearing streams with provision for reduction to no less than 50 feet with low and moderate intensity adjacent use, if vegetation is sufficient for sediment and nutrient control and shading.
Finding	The definition of low intensity and high intensity classifies commercial sites with up to 50 percent impervious as low intensity. This definition is not consistent with BAS, which indicates that impacts to aquatic habitat and species occur within a watershed with 10 to 15 percent impervious area.
Recommendation	Eliminate low and high intensity use as currently defined as a qualifier for buffer width. Intensity of use is primarily related to proximity issues such as noise, light and glare for wildlife habitat and for stormwater runoff (addressed below). Intensity is generally less relevant to processes that take place primarily inside the buffer such as LWD, shading and sediment/nutrient control. Provide new definition for use in buffer reduction as discussed above. In the case of reduced buffers, proximity impacts from high intensity use can have an effect on wildlife functions.

Recommendations	
Finding	LCC 35.35.689(c) provides for extending buffers where 50% slopes are present, however for functions such as sediment and nutrient control, the function degrades at slopes considerably less than 50%
Recommendation	Maintain the provision with a threshold of 25% slopes where buffers are less than 100 feet, the buffer would extend to a 30% greater dimension. In all cases, where slopes within the buffers above exceed 35%, the buffer would extend to 25 feet above the top of slope, or if a landslide hazard buffer is present, to whichever is greater.
Finding	Stream buffers are measured from the OHWM with no provision for including channel migration zones (CMZ). Where channel migration occurs or is likely to occur, a buffer measured from the OHWM may not fully protect riparian functions. Of particular concern is the ability of a stream channel to migrate (thereby recruiting LWD) and to form new instream habitat features such as pools, riffles, and off-channel areas important for several salmonid life stages. Areas of likely channel migration need to be determined, as does the feasibility of protecting CMZs where they do (or should) occur.
Recommendations	Incorporate CMZs into riparian buffers in Type S streams where CMZs have been previously identified as providing a key role in the maintenance of fish habitat. Where a CMZ occurs or could be expected to occur, stream buffers should be extend at least to the lateral edge of the CMZ to protect stream migration and habitat-forming processes. CMZs should be designated throughout the County by stream reach. In the interim, in lieu of CMZ the county could designate in specific areas other relevant process zones such as the flood-hazard boundaries or within specific areas on-site delineation of CMZs could occur on a case-by-case basis as needed. Exceptions would be necessary in cases where bank modifications, permanent structures (dikes, levees, etc.), or existing land uses effectively prevent channel migration.
Finding	LCC 17.35.680(2)(a) provides for Buffer Averaging with allowable reduction up to 50% of the width and to as low as 25 feet. It is unlikely that the functions designated as the basis of the buffers could be achieved within those limits.
Recommendations	Reduce averaging provisions to 75% and 50 feet and provide additional provisions limiting use to those cases where buffers cannot be met because of existing roads or other existing features.
Finding	LCC 17.35.680(2)(b) provides for Buffer Reduction with allowable reduction up to 50% of the width and to as low as 25 feet and reduction of area up to 17%. It is unlikely that the functions designated as the basis of the buffers could be achieved within those limits.
Recommendations	Eliminate this provision because buffer reduction with enhancement is incorporated in the dimensional requirements.
Finding	There are no performance standards for mitigation in instances of buffer encroachment.
Recommendation	Establish requirements and performance standards for mitigation of buffer encroachments when they occur.
Finding	No building setbacks from riparian buffers are required, which could result in buffer impacts due to construction activities or impacts to structures from the riparian buffer (e.g., hazard trees).
Recommendation	Establish a minimum building setback of 10 to 15 feet from buffers with provision for reduction based on specific building plans as proposed in the General Provisions.
Finding	Bank protection and flood protection, including flow control structures for regional retention/detention systems has the potential for substantial effects on natural stream processes and may require extensive review based on criteria to preserve ecological functions and development of mitigation as part of the program.
Recommendations	Criteria should provide that • New development should be located and designed to avoid the need for future shoreline stabilization. Subdivision should ensure that the lots created will not require shoreline stabilization. •

Recommendations	
Recommendations (conrinued)	• New structural stabilization measures should not be allowed except when necessary to protect existing primary structures when the structure is in imminent danger and nonstructural measures, such as placing the development further from the shoreline, planting vegetation, or installing on-site drainage improvements, are not feasible or not sufficient. • When structural shoreline stabilization measures are necessary, they should be limited to the minimum necessary and soft approaches shall be used unless demonstrated not to be sufficient. Specific standards for flood control structures should include consideration of stream processes, alternatives, and mitigation of impacts
Finding	In-water structures such as docks are not specifically addressed by the existing code and warrant specific criteria and standards.
Recommendations	Provide standards for dock and other inwater structure to address • Avoidance of areas preferred by juvenile Chinook salmon and other important species such as low-gradient habitats with sandy bottom; • Minimize the cumulative effects of over-water structures, in particular the loss of habitat and the potential creation of refuge for predators, • Minimization of the potential for predation on juvenile salmonids • Minimizing visual barriers to migrating fish; • Minimizing leachate from treated wood that is toxic to aquatic organisms.
Finding	Stormwater management standards currently used by Lewis County do not provide adequate flow control and water quality management to prevent long term geomorphic effects on streams and to maintain water quality
Recommendations	Adopt the 2005 Ecology Stormwater Management Manual for Western Washington as the basis for stormwater management
Finding	Low impact development techniques can reduce the amount and effects of impervious surfaces.
Recommendations	Review and amend county road and other standards and include provisions for site design that minimize the effects of impervious surface through design and materials (as well as stormwater detention and treatment facilities)
Finding	There is no provision for modification of buffers for water dependent or water oriented uses allowed by the Shoreline Management Act. The SMA recognizes a positive public benefit of use of shorelines for water dependent and water oriented use.
Recommendation	Add a provision allowing modification of buffers to accommodate uses allowed by Shoreline Management Substantial Development Permit, provided that impacts are mitigated to result in no net loss of shoreline ecological functions.

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